Measures for Environmental Sustainability Outcomes of Transportation Agencies

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Department of Civil and Environmental Engineering
College of Engineering
University of Wisconsin–Madison

Authors:
Teresa Adams, Daniel Moynihan, Benjamin Zietlow, Jon Fok, Eli Miller, Eric Oberhart, Emma Schumann and Fei Wang
University of Wisconsin–Madison

Principal Investigator:
Teresa Adams
National Center for Freight & Infrastructure Research & Education
University of Wisconsin–Madison

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16. Abstract: Sustainability and performance management are increasingly politically relevant topics, and while the USDOT goals of safety, infrastructure state of good repair, and economic development are known to be central to the mission of transportation agencies as well as well represented in their performance reporting, the non-traditional goals of livability and environmental sustainability are less well defined, are not commonly measured, and have yet to reach a level of pervasiveness within state DOTs. The study of public sector performance systems reveals that non-traditional measures of transportation-measures that do not match closely with the historical DOT mission to provide mobility for people and goods- are often left unmeasured and unlikely put to meaningful use. This report examines the current state of sustainability measurement guidance from international, national, and state perspectives; assesses commonly observed performance measures related to environmental sustainability and livability; and discusses ways to encourage the purposeful use of performance measures through organizational learning techniques. While the evaluated measures do not directly meet all requirements of their respective criteria, these criteria will help state DOTs develop potentially stronger measures going forward.			
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List of Acronyms

CBA: Cost Benefit Analysis
CDC: Center for Disease Control and Prevention
FHWA: Federal Highway Administration
GHG: Greenhouse Gas
LRTP: Long Range Transportation Plan
LTS: Level of Traffic Stress
MPO: Metropolitan Planning Organization
NCHRP: National Cooperative Highway Research Program
NOX: Nitrous Oxide
PM: Performance Measure
SOV: Single Occupancy Vehicle
TBL: Triple Bottom Line
THT: Transportation Health Tool
USDOT: United States Department of Transportation
VOC: Volatile Organic Compound

Executive Summary

The goals of safety, infrastructure state of good repair, and economic development are known to be central to the mission of state transportation departments, and are well represented in the performance reports of state transportation agencies. Recent federal transportation bills defined new strategic goals for America's transportation system. In addition to the traditional goals of safety, state of good repair, and economic competitiveness, the USDOT Strategic Plan for FY 2014–18 (USDOT 2014) identifies these non-traditional goals:

- Livability – Foster quality of life in communities through place-based policies and investments that increase the transportation choices and access to transportation services.
- Environmental Sustainability – Advance environmentally sustainable policies and investments that reduce carbon and other harmful emissions from transportation sources.

However, the issues of livability and environmental sustainability are less well defined, are not commonly measured, and have yet to reach a level of pervasiveness within state DOTs. The difficulty in measuring livability and environmental sustainability goals may be based on the complexity of the topic. What is meant by livability and environmental sustainability and how does transportation contribute to it?

The study of public sector performance systems can provide us with some salient insights. First, livability and environmental sustainability are non-mission based values; i.e., they do not flow from or align with the DOT mission to provide mobility for people and goods. Non-mission based values are often left unmeasured (Moynihan 2008). Second, even relatively important but unmeasured goals are given less attention relative to measured goals (Dixit 2002). The implication is that non-traditional measures of transportation—measures that do not match closely with the professional training values and training of officials in federal, state, and local transportation functions—are unlikely to be put to meaningful use.

This report presents the results from research that examined transportation agencies' current state of practice in regards to defining and implementing novel measures of livability and environmental sustainability within their mission of delivering and operating the transportation system. The audience for the report includes both transportation agencies currently using and those considering, but have not yet adopted performance measures in order to reflect progress towards these non-traditional goals.

This research was conducted as a joint effort between the National Center for Freight and Infrastructure Research and Education and the Robert M. La Follette School of Public Affairs, both at the University of Wisconsin – Madison. The project was funded by the USDOT Region 5 UTC, NEXTRANS at Purdue University. Work was performed between December of 2015 and December of 2016.

The project activities include literature review, survey and analysis. Environmental sustainability performance measures were collected from each state's department of transportation website and by direct email to all state DOTs inquiring as to use of environmental sustainability performance measures. The data collection effort included Google searches for annual performance reports, annual statewide transportation plans, state transportation improvement

plans, and long-range transportation plans. The assessment for livability performance measures was accomplished by surveying state and regional transportation plans. Transportation plans such as the statewide long-range transportation plans are evaluated as well as non-vehicle mode choice plans to account for multi-modality and active transportation. The objectives were to:

- Characterize the longitudinal development of transportation performance measures for livability and environmental sustainability.
- Benchmark the current implementation of performance measures related to livability and environmental sustainability at state Departments of Transportation.
- Identify and assess tools and other frameworks available to transportation agencies for assessing livability and sustainability efforts.
- Assess the strength of currently used performance measures.
- Identify examples of innovative model measures.
- Review successful implementation and organizational learning.

Organizations such as the World Economic Forum, the United Nations, and the U.S. Army have highlighted and stressed the important role both transportation and transportation policy play in establishing and promoting a sustainable society. Research suggests however, that today's policy environment within the U.S. is not up to the task when it comes to supporting a sustainable society via a triple-bottom-line perspective. Despite growth in the number of measures for sustainability, there is little evidence the measures are used for decision making. As in other areas of governance, transportation agencies struggle to establish patterns of use of sustainability performance metrics.

Currently, performance measures for sustainability at state DOTs focus on reducing the environmental impacts of transportation without regard for the roles that transportation infrastructure and services play within our complex society.

Measurement is further complicated by the impacts of other programs, some of which are in the field of transportation, and some in other policy areas. For example, the Environmental Protection Agency (EPA) together with the U.S. Department of Housing and Urban Development (HUD) and the U. S. Department of Transportation (DOT) formed the Partnership for Sustainable Communities, a collaboration between the three federal agencies to help improve access to affordable housing, create more transportation options and lower Americans' transportation costs while protecting the environment in communities nationwide ("Sustainable Communities" n.d.). This fragmentation underscores both the need for greater attention to the performance of such programs, as well as the difficulty in finding summary measures of success.

What is needed is a shift in culture away from our historical reliance upon civil engineering based problem solving to one of systems thinking that connects multiple agencies and jurisdictions, and instills a culture of sustainability that governs the planning, design, investment, and use of our transportation resources. FHWA's INVEST and the UK-based CEEQUAL are self-assessment tools to help transportation agencies integrate sustainability best practices into the transportation life cycles. California's Sustainable Communities Act of 2008 (SB 375) is a

framework to reduce greenhouse gas emissions from transportation via integrated land-use and transportation planning to model.

The most widely used measures of sustainability assess recycling, alternative fuels, air-quality and emissions, resource consumption, and wildlife and habitat considerations. This report contains the specific metrics reported at the agency level. A lesser-known measure that scores high on innovation, is *Percent of Urban Roads with Sidewalks and Bikeways*. This measure, being used by the Oregon Department of Transportation, has a good deal of potential value if used in other settings also.

While Long-Range Transportation Plans (LRTP) address social sustainability and livability, most performance measures within these plans, and in general, are presented in economic and environmental terms. The interest in measures for environmental sustainability within transportation may be attributed to the desire to monetize environmental benefits which then can be used to address environmental sustainability within a cost benefit analysis (CBA) framework. This is a reasonable path for maturing capabilities of CBA and a natural progression for using CBA as a decision tool for investment such as for federal discretionary spending like the TIGER Grant program. This momentum is juxtaposed with the apparent lack of progress in measuring the transportation system's impact on improving the quality of life within communities, which has morphed into something more concrete like health. Performance related to public health and active transportation is difficult to define so the measures tend to be indicators rather than outcomes. Measures related to access/connectivity and equity also suffer from a difficulty in monetizing the benefits, as well as the fact that the transition from mobility to accessibility in transportation planning is still in the early stages.

Finally, purposeful and deliberate use of performance measures in day-to-day decision making across all levels of transportation agencies, driven by top leadership down to the staff level, is required for performance information to ultimately produce results in public outcomes. Quantifiable, aggregated, and transparent performance information that goes beyond financial data to include a specific focus on results drives purposeful usage of such data, while a mature performance management system and external stakeholder involvement are critical to the overall success. Transportation agencies seeking to embed the nontraditional measures of environmental sustainability and livability within their organizational culture should embrace double-loop learning to continually reassess the basic assumptions that underline their mission and key policies.

Introduction

The purpose of transportation is to provide safe, efficient opportunities for the movement of people, goods and services. Changes in land-use developments and sustainability initiatives in the United States have resulted in increasing and more complex challenges to the design of transportation networks. The United States Department of Transportation (USDOT) has adopted national initiatives to adapt to such changes. The USDOT created an emphasis on performance-based measures to track progress towards the national goals for surface-transportation programs in conjunction with the Moving Ahead for Progress in the 21st Century (MAP-21) Act in 2012 and the Fixing America's Surface Transportation (FAST) Act in 2015. The USDOT highlights five strategic goals in its 2014–18 Strategic Plan (USDOT 2014): Safety, State of Good Repair, Economic Competitiveness, Quality of Life in Communities, and Environmental Sustainability.

Federal and state agencies already regularly incorporate performance measures for the first three goals in state and regional transportation plans: safety, state of good repair and economic competitiveness. However, there are challenges in developing and implementing performance measures for environmental sustainability and quality of life in communities. The main challenge to reach both goals is the ability to develop consistent performance measures to track progress. State and regional planning agencies have moved toward environmental sustainability, but not all states have developed or implemented such performance measures. There continues to be a big obstacle incorporating livable community performance measures in state and regional transportation plans as transportation planning agencies are figuring out how to measure livability.

The framework of USDOT's strategic plans allow flexibility regarding how state DOTs and MPOs address the strategic goals in long-range transportation plans and other transportation-related plans so that the plans are relevant to the respective geographical area. MAP-21 provided basic definitions from the USDOT describing each goal, but state and regional transportation planning agencies were given the flexibility to develop strategies and measures for each goal as needed for their specific regions. Such actions and responsibilities resulted in variable use in types of performance measures thus leading to inconsistencies in performance evaluation.

The FAST Act of 2015 continues to require state DOTs and MPOs to address performance goals, measures and targets in long-range plans and short-term transportation improvement programs (TIPs), particularly with intercity transportation. However, the FAST Act looked to hold state DOTs and MPOs accountable by assessing the progress made toward proposed performance goals in long-range plans and short-range programs. The purpose is to ensure that states are not only achieving the performance targets, but ensure that states and MPOs make progress towards the overarching national goals.

Federal guidance on the application of sustainability in transportation performance management is limited, and as a result, states are taking varied approaches to measuring sustainability. As with other aspects of transportation, there is no consensus on a set of performance measures that have been in use for a significant period. At the same time, motivated agencies are developing their own measures at the state and local levels.

Sustainability is a broad and complex concept that, in ideal circumstances, should permeate all levels of an organization and its culture. Achieving a wide-spread culture of sustainability within the institution of a state DOT may be difficult because DOTs are large, perform a wide range of tasks, and serve varied populations and geographies. Existing organizational cultures that have not been attentive to sustainability might be difficult to change. However, these same organizational characteristics mean that utility of sustainability measures could yield substantial environmental, social, and economic benefits for a state and its residents. Given the conceptual complexity of sustainability, it can be difficult to gather a sense of a state DOT's progress towards achieving fully sustainable projects and programs, but well-designed performance measures can be used to gain an understanding of the whole organization's sustainability performance.

Traditionally State Transportation Agencies used performance measures to evaluate transportation system safety, system quality, mobility, strategic projects, and overall program delivery. Sustainability and performance management are becoming increasingly politically relevant. State governments are expecting state agencies to qualitatively demonstrate their progress toward strategic goals, and to pursue some degree of sustainability in their plans and policies. While some DOTs may not see an immediate need to engage in sustainability-related performance management, changing state and national politics may dictate that sustainability performance measurement is required in the near future.

Sustainable transportation policy takes many forms at state DOTs. In fact, many states' current policies could be considered sustainability policies. For example, programs like transit service can be viewed as supporting environmentally and socially sustainable outcomes by reducing reliance on inefficient automobiles and providing mobility to disabled, elderly, and low-income individuals. These and other existing programs that are sustainable in nature provide a strong foundation for development and adoption of sustainable transportation performance measures.

In this report, we discuss guidance toward sustainability from four distinct perspectives and present the current scope of agency-level environmental and livability sustainability measures being used at state transportation agencies (collected by web search and agency survey). Next, we describe three sets of criteria used to assess the strength of performance measures being used at transportation agencies. Those criteria are applied to common and uncommon sustainability measures found in existing state DOT performance measurement systems. Finally, we describe ways in which state DOTs can engage in organizational learning to implement sustainable transportation measurement systems so that considerations of sustainability are embedded in future transportation program, projects, and planning efforts.

PART I: Current Status of Transportation Agency Performance Measures for Sustainability

The scope of guidance for measuring impacts of transportation on sustainability has expanded in recent years. The World Economic Forum's annual Global Risks Reports ("Global" 2017) accentuate transportation's connections permeating society culminating most profoundly in trends such as environmental degradation, climate change, and urbanization, as well as in less direct ways like rising geographic mobility, growing middle classes in emerging economies, ageing populations, and rising income disparities. Transportation is either impacted by or impacts each of these trends among other risks and trends listed in the report.

The U.S. Army also understands the important role transportation plays in the construction of a sustainable society, as well as the need for policy to accomplish the goal: "Transportation is the 'web of union', and sustainability of systems relies upon political will. Sustainable transportation is the result of intentional policy at the strategic level and potentiates unified governance and economic growth (Allen and Albert 2014)." However, the current policy environment in the U.S. is unable to effectively support the basis for a sustainable triple-bottom-line future. The NCHRP Report 750 Volume 4 (Booz Allen Hamilton 2014) provides recommended strategies and methods to help transportation agencies anticipate a triple-bottom-line (TBL)[1] sustainability policy in the near term.

The U.S. overall policy system and institutional framework today is not yet capable of making the strategy, policy, and funding decisions that are truly driven by TBL considerations. A TBL policy system will evolve slowly from now, because of the very significant changes that will be needed in institutional, governance, and funding mechanisms – for the TBL system to work.

Current DOT based sustainable performance measures (PMs) are generally focused on making transportation environmentally friendly in and of itself. However, this fails to fully recognize and leverage the roles the transportation system and its services play within the context of a Triple Bottom Line regionally, nationally, and globally, both now and in the future. Instead, a move away from transportation's civil engineering roots (where we continually build to meet demand) and towards a foundation of systems thinking, which attempts to jointly create a transportation system across multiple agencies and jurisdictions, that is less expensive, less resource and carbon intensive, and more accessible is needed.

Also needed are performance measures that follow in a similar scope by focusing on transportation services rather than infrastructure projects and measures that place services within the social, environmental, and economic systems in a way that requires us to address the complexities and synergies that form the basis of our society. Ultimately, collaborations, dialogue, and strategies for shifting to a system-level culture of sustainability that governs the planning, design, investment, and use of our transportation resources is warranted.

[1]A policy system that is intended to manage and preserve an optimum balance in the value of economic, environmental, and social well-being for future generations.

Guidance Tools for Sustainability Practices of Transportation Agencies

The guidance tools for sustainability performance in transportation were developed from different perspectives but all implement triple-bottom-line concepts. The following sections review performance measurement guidance for sustainability goals of transportation systems. The first is representative of common international values among member states of the United Nations. The second example is from the Federal Highway Administration of the U.S. Department of Transportation. This guidance is representative of national values to facilitate balanced decision making among environmental, economic, and social values—the triple bottom line of sustainability. The third example is from the state of California and is driven by the desire to reduce GHG emissions from transportation. The final example is CEEQUAL, originally developed by the UK Institution of Civil Engineers (ICE).

The United Nations Sustainable Development Goals

The United Nations (UN) recognizes the important role transportation plays in developing a sustainable society, and encourages sustainable transportation to be understood through the lens of inclusive and equitable growth, social development, and protection of the global environment and its ecosystems—in other words, the Triple Bottom Line.

In its analysis of transportation's relevance to each of the UN's 17 Sustainable Development Goals (SDG's), the High-level Advisory Group on Sustainable Transport's Technical Working Group on Transport reported, "the fact that transport related targets are included in eight out of the seventeen proposed SDG's illustrates the cross cutting role that transport has in sustainable development." The direct and indirect connections are presented in Table 1 ("Transport TWG" 2015). The report drives home the point that transportation "plays a vital role in contributing to all SDG's. It becomes clear that transport has to be understood as means to an end."

The report further states, "transport is necessary and acts as a vital enabler." In the broadest sense, transportation networks are public assets providing citizens with access to a number of services needed in daily lives, and it is achieving this access that will enable the UN to meet many of its 17 SDGs. Affordable, reliable, and efficient transportation allows people to access water safe for consumption, nutritious food, education, jobs, health care, and other goods, and to participate in politics and social activities. It allows businesses to reach local consumers and other markets. However, while providing access, transportation also produces negative externalities (traffic congestion, pollution, and crashes) that must also be considered as they threaten the sustainability of the environment and the health of people.

Table 1. United Nations' Transportation-Related Sustainable Development Goals

Goal	Strategy
End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, markets and opportunities financial services for value addition and non-farm employment
Ensure healthy lives and promote well-being for all at all ages	By 2020, halve the number of global deaths and injuries from road traffic accidents By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination
Ensure availability and sustainable management of water and sanitation for all	By 2030, achieve universal and equitable access to safe and affordable drinking water for all
Ensure access to affordable, reliable, sustainable and modern energy for all	By 2030, double the global rate of improvement in energy efficiency
Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all
Make cities and human settlements inclusive, safe, resilient and sustainable	By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
Ensure sustainable consumption and production patterns	By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities
Take urgent action to combat climate change and its impacts	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries

U.S. Federal Highway Administration's INVEST TOOL

The Federal Highway Administration's (FHWA) Infrastructure Voluntary Evaluation Sustainability Tool (INVEST) is part of its Sustainable Highway's Initiative, which *supports programs and activities conducted across the Federal Highway Administration to facilitate balanced decision making among environmental, economic, and social values—the triple bottom line of sustainability*.

The INVEST Tool ("INVEST" 2015) identifies characteristics of sustainable transportation and provides information and techniques to help agencies and organizations integrate sustainability best practices into the entire transportation life cycle: early planning, alternative analysis, environmental documentation, preliminary and final design, construction, and operations and maintenance. The tool is intended to encourage discussion, self-reflection, and, ultimately, sustainable practices by providing a method for practitioners to self-evaluate their transportation planning, projects, and operations and maintenance activities. It is a free, web-based tool; however, FHWA does not require its use, and it is not intended to be used to compare across transportation agencies or projects. The tool has been developed with ongoing input from state and local transportation agency officials and staff and professional organizations, such as AASHTO and ASCE. FHWA plans to continue to update this tool as the transportation sustainability field advances.

INVEST defines **sustainability** using the "triple bottom line" for the three primary principles: Social, Environmental, and Economic. The goal of sustainability is the satisfaction of basic social and economic needs, both present and future, and the responsible use of natural resources, all while maintaining or improving the well-being of the environment on which life depends. Because sustainable transportation projects and systems serve many different and sometimes competing objectives, a sustainable approach for FHWA means helping decision makers meet all of their needs while hitting economic targets for cost-effectiveness throughout an asset's life cycle.

The INVEST Tool is broken down into four separate modules depending on the activity the transportation agency would like to evaluate: two focused on an agency's system-level planning, programming, policies, processes, procedures, and practices, such as its Long Range Transportation Plan and similar documents; one focused on the different types of project development; and one focused on operations and maintenance activities. FHWA does not expect agencies to score efforts across all modules; rather, the tool is envisioned as providing a guiding framework on how to incorporate sustainability into planning, project development, and operations and maintenance efforts—past, present, and future.

FHWA provides a number of resources on the INVEST website to assist agencies. These include case studies, time estimates to implement the tool, a user guide, webinars, information on the cost savings from the various criteria in the modules, and an INVEST Library containing the modules, scoring questions, and a user toolkit among others. Each criterion includes a title, goal, scorecard graphic (for the project development module), sustainability linkage text, affected triple bottom line graphic, scoring requirements, resources for more information, and scoring sources. Also available is a "Cost Savings Report," which provides narratives that can be used to measure and quantify agency cost savings as well as the economic, environmental, and social-equity benefits or savings (to the users) resulting from the implemented sustainability

criteria. It can be used to make the business case to senior-level management and other stakeholders and to influence public opinions or raise awareness of sustainability.

California's Sustainable Communities Act of 2008

In 2008, the state of California passed *California's Sustainable Communities Act of 2008 (SB 375)* to integrate land-use and transportation planning and to reduce GHG emissions produced by the transportation system. In particular, it focused on reducing the carbon emitted by vehicles, the carbon levels in fuel used for transportation, and the distance of vehicle trips. The bill requires metropolitan planning organizations to "adopt a sustainable communities' strategy (SCS) to achieve certain goals for the reduction of greenhouse gas emissions from automobiles and light trucks in a region." It also requires the State Air Resource Board to provide regions with GHG reduction targets and to appoint a Regional Target Advisory Committee to recommend factors and methodologies for setting those targets.

The SB 375 Factsheet describes a Sustainable Communities Strategy as "a long-range vision of how a region's housing and transportation plans will meet its GHG emissions reductions target" while incorporating a Regional Housing Needs Assessment (RHNA) requirement to provide housing to accommodate *all income* groups. According to the bill, the SCS shall (among others):

- Identify the general location of uses, residential densities, and building densities within the region
- Identify areas within the region sufficient to house all the population of the region, including all economic segments of the population, over the course of the planning period of the RTP, taking into account net migration into the region, population growth, household formation and employment growth
- Identify a transportation network to service the transportation needs of the region
- Set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the GHG emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the GHG emission reduction targets approved by the state board.

A number of performance indicators[2] are given as examples in the Description of Methodology for ARB Staff Review of Greenhouse Gas Reductions from Sustainable Communities Strategies (SCS) Pursuant to SB 375. Examples of indicators include, but are not limited to:

- Passenger vehicle miles traveled
- Commute trip mode shares (drive alone, carpool, bus transit, bike, and walk)
- Residential Density (number of housing units per net residential acreage developed and population per net residential acreage developed)

[2]Indicators and performance measures are different in this case. Indicators evaluate forecasted changes in GHG emissions from the current conditions due to proposed regional transportation plans and sustainable community strategies. Performance measures evaluate the changes in outputs from the "performance and effectiveness of the transportation system, policies, and programs."

- Distance of housing and employment from transit stations (percentage of housing units and total employment within ½ mile of all bus and rail transit stations)
- Bike and walk trips (number of bike/walk trips and percentage of bike/walk trip mode share)

CEEQUAL

According to its marketing material ("CEEQUAL" 2015), "CEEQUAL is an international evidence-based sustainability assessment, rating, and awards scheme for civil engineering, infrastructure, landscaping, and other public space projects during the development, design, construction, and operation stages." The tool is a pay-for-play, 10-step assessment process that can be used for single projects or for term contracts undertaken over a number of years and in a geographical or operational area to take into account the way contracts are procured, managed, and delivered. Benefits from its use include improvements in projects' whole-life costs, waste reduction and improved resource utilization (materials, water, and energy), positive boosts to public relations and company reputations due to ensuring that sustainability is an important design consideration, and improved project management.

Like INVEST, CEEQUAL is a self-assessment tool that can be used by an internal assessor; however, unlike INVEST, CEEQUAL requires a trained-assessor and CEEQUAL-appointed verifier before an award and certificate are granted.

CEEQUAL assesses issues related to the triple-bottom-line concept of sustainability (by achieving concurrent economic, environmental, and social success) and seeks to complement the planning system and clients' financial and economic models including a project or contract's effects on neighbors, and community relations. "CEEQUAL as a rating system does not assess a particular planning system or collection of planning systems, but rather whether a project or contract is helping the community or communities it serves to live more sustainably." Despite this, it is able to integrate sustainability into the infrastructure professions and industries by providing an incentive and protocol for assessing, benchmarking, and rating the sustainability performance of individual projects and contracts.

CEEQUAL offers assessments for projects (examples include roads, dams, business parks, canals, bridges, ports, flood alleviation, pipelines, wind farms, power generation and transmission systems, railways, wastewater treatments facilities, waste transfer and recycling facilities, sea locks, and anaerobic digesters) as well as term contracts (such as highway, rail, or sewage maintenance, or the regular dredging of waterways to maintain capacity). The project team can decide if it wants its strategic approach evaluated as well, or just its performance carrying out the work. Assessments are broken down into nine sections: Strategy, Management, People and Communities, Land-use and Landscape, Historic Environment, Ecology and Biodiversity, Water Environment, Physical Resource Use and Management, and Transport.

Environmental Sustainability Performance Measures at Transportation Agencies

This section examines how state agencies are measuring sustainability performance. Measuring environmental sustainability in transportation networks and projects is increasingly emphasized among state DOTs. Researchers and environmental advocates suggest doing so can help in understanding and reducing the negative effects modern transportation systems have on the

environment. While the USDOT has encouraged adoption of sustainable performance measurement systems, only eighteen state DOTs and the District of Columbia have implemented performance measures for environmental sustainability. Since the 1980s, the definition of and ontological stability of sustainability has varied, but the overall idea of preserving opportunity or resources for future generations is the key element. Measuring transportation sustainability is beneficial because it helps ensure present transportation needs are met without compromising the ability of future generations to meet their needs. According to NCHRP Report 708 (Zietsman et al. 2011), “sustainability involves meeting human needs for the present and future while preserving and restoring environmental and ecological systems; fostering community health and vitality; promoting economic development and prosperity; and ensuring equity between and among population groups over generations.” The USDOT’s 2014–2018 Strategic Plan (USDOT 2014) established three broad goals specifically supporting environmental sustainability: 1) reducing oil dependence and carbon emissions; 2) avoiding and mitigating transportation-related impacts to climate, ecosystems, and communities; and 3) promoting infrastructure resilience. These goals implicitly support social and economic sustainability as well.

Between December 2015 and May 2016, the researchers collected lists of environmental sustainability performance measure in use at U.S. state transportation agencies state and the District of Columbia. Three methods were used to collect the information. First (1), searches of each state’s department of transportation website to locate their environmental sustainability PMs. Second (2), Google searches for documents that might contain performance measures such as annual performance reports, annual statewide transportation plans, state transportation improvement plans, and long range transportation plans. Third (3), direct email to each state transportation agency inquiring into their use of environmental sustainability PMs. Twenty-three states and DC responded to our email inquiries on their state’s use of environmental sustainability PMs. In every case, the email correspondence corroborated the data collected using the web searches, suggesting that the open-source approach to data collection was generating valid reflections of what states were actually doing. Specifically, six states and DC confirmed their use of environmental sustainability PMs, 17 states confirmed that they are not using environmental sustainability performance measures, and 27 states did not respond to the email inquiry.

Together, the states currently using (eighteen states and the District of Columbia) or with plans for use in the future have a total of 88 sustainability performance measures. Massachusetts had the most measures (17), followed by Oregon (17), and Maryland (10). Although each of these states measure environmental sustainability with varying indicators, measures generally monitor five broad categories: 1) usage of recycled materials (e.g., recycled pavement), 2) usage of alternative energy sources, 3) air quality and emissions, 4) agency energy and resource consumption, and 5) land use or habitat preservation (Table 2). The table lists the categories that best describe the states’ PMs. Appendix A lists the performance measures used by each state.

Table 2. Thematic Categories of Environmental Sustainability Measures for State Transportation Agencies

Category	Description	States
Recycled Materials	Measures assessing percentage of materials being recycled OR use of recycled material in new projects.	FL, IL, MO, NE, OR, WI
Alternative Fuels	Use of alternative energy assessed as percent of alternative fueled vehicles in the agency fleet, amount (total) of alternative fuels being used. Number of alternative fuel vehicles in use, etc.	FL, LA, MA, MO, OR
Monitoring Emissions and Air Quality	Emissions from DOT facilities and vehicles.	MA
	Emissions and pollution from transportation system as whole.	CA, DE, FL, HI, LA, MD, WA
	State's overall emissions.	CA
Resource Usage	Energy, water, or other resource usage for DOT facilities and/or vehicles.	MA, MO, NH, OR
Wildlife Habitat	Documenting land-use changes and habitat preservation efforts. Consideration of habitat (including wetlands) preserved or restored.	FL, LA, MD, OR, WA

The majority of states have yet to utilize environmental sustainability PMs. During the data collection process, however, it became apparent that many states are interested in adopting environmental sustainability PMs. Thus, the data collected in this report will be useful to states that are considering, but have not yet adopted, sustainability PMs, as well as those states that are currently using environmental sustainability PMs, as PMs are frequently reassessed and revised to improve their effectiveness.

Livability and Social Sustainability Performance Measures at Transportation Agencies

A challenge in identifying performance measures for livability comes from being able to differentiate between social sustainability and livability. In many state and regional transportation plans, social sustainability and livability are often considered the same when addressing the national goals set forth by USDOT. Sustainability is referred to as the balance between the built and natural environments to support present and future generations ("Sustainability | US EPA" n.d.). The balance between the two environments for sustainability is addressed through economic, environmental and social goals, which is known as the "triple bottom line." Meanwhile, livability is also defined as the balance between the two environments but focuses on the direct impact on quality of life and community development. Since both livability and sustainability in transportation often address similar goals and objectives, the differentiation between the two is often overlooked.

As communities continue to grow and land uses change, the challenge for transportation planning agencies is to evaluate transportation systems for community development. There is a consensus agreement that transportation systems have influence on other factors with community development, particularly quality of life. Transportation-related emissions have been linked to chronic illnesses and other public health problems.

Livability, as defined by the Victoria Transport Policy Institute (VTPI), refers to sustainability impacts that directly affect community development (Litman 2016). While sustainability is often referred to as a triple-bottom-line framework with economic, social and environmental components, these performance measures do not always directly relate to community development. Therefore, state DOTs and regional planning agencies are working to develop new performance measures to foster improved quality of life and community initiatives through multimodality and access to amenities. State DOTs and regional planning agencies are also collaborating with other agencies to integrate performance measures that are not solely relevant to transportation such as active transportation and transportation-related health factors.

The assessment for livability performance measures by state DOTs was done using multiple state and regional transportation plans. Transportation plans such as the statewide long range transportation plans are evaluated as well as non-vehicle mode choice plans to account for multi-modality and active transportation. Multi-modality has been a focus for planning agencies to address accessibility constraints from physical barriers that prevent non-vehicle usage along with equity issues for households that are reliant on public transportation or other non-vehicle mode choices for travel. Initiatives toward active transportation have been among the top priorities to address public health issues, such as asthma and obesity, from physical inactivity.

Measures for Transportation Accessibility

The understanding of PM development and implementation comes from the applied principles used by State DOTs and other transportation planning agencies across the United States for evaluating transportation systems. Since the end of World War II, there are two principles that have been considered fundamental in transportation planning: that travel is a derived demand and that generalized costs are minimized through travel costs and travel time (Banister 2008). The highway and interstate systems, once used for military purposes, provided opportunities for the increasing popularity in vehicles as well as incentives for people to live in areas outside of over-populated urban areas. The increasing popularity of vehicles also came about because of the negative perception of public transportation, which once was merited to mass corruption among private companies that operated public transportation systems in the earlier 20th century. The shift in transportation mode choice preferences and community expansion led to transportation planning agencies throughout the U.S. using a mobility-based approach to constructing the transportation system. Three components mainly define the mobility-based approach: speed, flow and capacity. With each component, transportation planning agencies thus could develop performance measures to track progress and evaluate their transportation systems that enabled safe and efficient travel between urban and newly built suburban areas. One of the biggest concerns with mobility-based planning is the handling of traffic congestion. Throughout the twentieth century, state DOTs and regional planning agencies have relied upon remediating traffic congestion by building more capacity; however, this is not a sustainable solution as expansion has only begot more congestion. Induced travel demand from roadway expansions, environmental concerns, and transportation inequalities are some of the reasons

that have transportation planning agencies considering new ideas for improving transportation systems. The biggest question for state DOTs and regional transportation agencies is not whether people are using the transportation system, but how people are using it.

An accessibility-based transportation planning approach revolves around access to services and amenities. Accessibility-based planning is comparable to mobility-based planning in that speed, flow, and capacity are important factors. But, it also evaluates additional components: proximity, network connectivity, and quality of mode-choice facilities. While mobility-based planning looks at getting people from their origin and destination as safely and efficiently as possible, accessibility-based planning looks at where trip origins and destinations are in relation to mode-choice facilities.

While the focus of mode-choice facilities in mobility-based planning often was on arterial and collector roadways, the focus in accessibility-based planning also includes sidewalks, bicycle paths and public transportation stations. The importance of addressing proximity to trip origins and destinations becomes more apparent with built environments, leading to issues with restrictions to amenities and disparities in areas like income and public health.

The researchers reviewed state DOT documents to identify the scope of livability performance measures that have been defined and the level of implementation. A few examples are as follows:

Average Number of Jobs in Proximity of Residence. The Delaware Department of Transportation in the 2010 Long-Range Transportation Plan Policy Report provides information on the evaluating travel times with respect to employment. The performance measure evaluates the number of jobs within fifteen minutes of residential areas to identify the interaction between mode choice and employment given the commute time. While the performance measure does not take well into consideration employees that reside outside of the given commute time, the performance measure provides further opportunities to identify the impact of commercial activity on residential areas and vice versa.

Percent of Urban Roads with Walkways and Bikeways. This measure, adopted by the Oregon Department of Transportation, assesses active transportation in urban areas. The performance measure, which is adopted in the 2016 Bicycle & Pedestrian Plan, provides the commitment by the state and other planning agencies to collaborate on an evaluation and consideration to incorporate bicycle and pedestrian facilities into the transportation system. The performance measure provides the department opportunities to report the progress toward including bicycle and pedestrian facilities to the transportation network to improve accessibility and connectivity in urban areas. The performance measure also supports the initiatives in the state of Oregon to coordinate efforts toward land-use and transportation planning goals.

Housing Units in Proximity to Public Transportation. The Washington State Department of Transportation is adopting this performance measure to address livability by evaluating the proximity of housing units and types near public transportation. The performance measure is under evaluation in the 2016 Public Transportation Plan and the department hopes to identify the impact of public transportation on improving accessibility in residential areas. The plan does, however, mention that future measures need to be developed, but encouragement of addressing universal access constraints in residential areas provides opportunities to track progress toward improving transportation equity, particularly in environmental justice communities.

Categories for Livability Performance Measures

The performance measures used in state and regional transportation plans for livability can be categorized into five groups: safety, access/connectivity, active transportation, equity, and public health.

Safety. The performance measures for safety evaluate fatalities and serious injuries on the transportation networks. State and regional planning agencies are focusing on the national initiative of zero fatalities on roadways. The focus is apparent in all the transportation plans provided by state and regional planning agencies as safety is listed as a strategic goal by all states. The main performance measures included in many of the plans were fatality rate and serious injury rate per vehicles miles traveled (VMT). The extent of VMT ranged from one hundred thousand to one hundred million miles. The same agencies are also looking to improve safety for alternative mode choices to encourage use, particularly in highly populated areas.

Access/Connectivity. These performance measures evaluate transportation network connectivity and access to amenities. The issue becomes more apparent when considering physical barriers that negatively affect the preferred mode choice for travel. An important note on transportation network connectivity is that network connectivity refers to accessibility to different locations, such as employment and residential areas. Such performance measures include average number of jobs within a certain travel distance and the number of transit stations within a given proximity of residential areas. Such performance measures revolve around not only access to the destinations but also mobility between the origin and the destination by different mode choices.

Active Transportation. Performance measures for active transportation refer to the presence of multi-modal facilities and physical activity. As multi-modality becomes an initiative in transportation plans, having clear performance measures is important to track progress toward regional and state strategic goals. The same performance measures also have potential applications in health impact assessments and other public health reports that monitor physical activity. Some examples of performance measures for active transportation include percent change of roadway systems with bicycle lanes and percent change of children walking and bicycling to school through safe ride to school programs.

Equity. Equity performance measures refer to equal opportunities for all. Transportation equity looks at improving universal access and mobility in the transportation system, especially in environmental justice communities. The main performance measure that is often used in transportation plans is percent changes in mode choice distribution. As communities look to address livability into future transportation plans, mode choice distribution, particularly for alternative mode choices, will become a more important focus. Such examples of equity performance measures include percent of sidewalks along state-owned roadways that are compliant with the Americans with Disabilities Act (ADA) and changes in population within a certain distance of a rail station or bus line.

Public Health. The role of transportation on public health is being associated with ongoing health concerns in the U.S. Many state and regional planning agencies use air quality and emissions performance measures to evaluate transportation-related pollution for environmental sustainability. The correlation between physical activity and transportation also has been

documented in relation to public health topics such as chronic illness and obesity. One such PM is the percent change in physical activity from walking and bicycling.

The Transportation and Health Tool (THT) was developed by the USDOT and Center for Disease Control and Prevention (CDC) ("Transportation and Health Tool" 2015). The tool can be used to assess how states and communities are performing relative to one another on a range of health-related transportation system indicators. The THT uses 14 indicators: alcohol-impaired fatalities, commute mode share, complete streets policy, housing and transportation affordability, land-use mix, person-miles traveled by mode, physical activity from transportation, proximity to major roadways, public transit trips per capita, road traffic fatalities by mode, road traffic fatalities exposure rate, seat belt use, use of federal funding for bike and pedestrian facilities, and vehicle miles traveled per capita. Since its release in 2015, the THT has provided states with information that can be used to identify disparities in their transportation systems that affect public health. However, the scale of the data presented in the THT is not useful for cities; cities require data at the neighborhood or district level.

There are a few common trends that are identified throughout the analysis of transportation plans by state and regional agencies. The first trend is that performance measures for livability are not always present in transportation plans. The Long-Range Transportation Plans (LRTPs) for many states address social sustainability and livability, but most of the performance indicators are presented in economic and environmental terms. Common performance measures evaluate mode choice with cost per benefit or amount of delay, which do not directly relate to livability. There are some environmental performance measures that have some relation to livability, such as noise and air quality. However, those measures do not directly relate to livability. Alternative transportation plans, such as bicycle and pedestrian plans, transit plans, and multi-modal plans, do provide some insight on addressing livability, yet the information is quite limited. Some states, such as California and Pennsylvania, are currently in the process of updating their alternative transportation plans, and therefore a future evaluation will be needed to determine how these states and other such states incorporate performance measures to address livability.

While the plans provide opportunities to improve the quality of life in communities, not all have established performance measures for evaluation. Many states are in the transition phase from conventional mobility-based planning strategies to accessibility-based planning. Performance measures for conventional mobility-based planning, such as roadway capacity and travel-time delay, continue to be used to evaluate transportation system performance. The main issue with time-related performance measures is that the perception of time can be considered more as an economic performance measure than a performance measure for social sustainability or livability. Examples like travel times and travel delay are often incentivizing one mode choice or another, which in turn relates to a monetary gain or loss. The perception of time in monetary terms becomes more apparent during discussions concerning employment commuting in many state and regional transportation plans. However, the relationship between transportation and community development in recent years has influenced many agencies to develop new performance measures that reflect the influence of transportation on the community.

The most common strategies addressing livability by state and regional plans are through safety and multi-modality. Fatality and serious injury rates per VMT are present in all long-range transportation plans, but do not always highlight fatality or serious injury rates for other mode

choices. There are some state and regional planning organizations that address safety for other mode choices, but the majority present safety information pertaining only to vehicles.

Most state and regional planning agencies that developed alternative transportation plans do well to address the progress toward constructing facilities for alternative transportation mode choices as performance measures. Some plans address performance measures by progress done to make existing roadways compatible for bicycling and walking, or their ability to incorporate *Complete Streets* instead of constructing infrastructure specific for only one mode choice.

Performance measures that address equity are mostly related to proximity, with certain distances to access certain transportation facilities (bicycle, pedestrian, transit). Some equity performance measures are specific to employment or residential areas. While the performance measures for equity are positives toward addressing livability, there are many states that are still developing performance measures to further evaluate equity, especially for underserved communities.

The final trend identified in the analysis is the lack of performance measures that attribute to public health. Despite efforts to incorporate public health into performance measures, states have addressed public health performance measures as a subset to other themes, not necessarily as a stand-alone theme. The common public health performance measures found in state and regional plans are with regard to younger children and seniors. Active transportation related to safe routes to school programs (bicycling, walking) appear as a focus on state and transportation plans to encourage physical activity for children. Other than that, there are few performance measures that relate to public health.

Alternative transportation plans (bicycle, pedestrian, public transportation) are often referenced in long-range transportation plans that outline strategies for integrating multi-modality into the transportation network. Performance measures, such as mode choice distribution and annual ridership over multiple year spans, provide some information about multi-modal integration, but do not necessarily address community livability. However, performance measures that address proximity to alternative transportation facilities, especially to residential areas and alternative transportation network connectivity, provide some context into travel behavior and the interaction between the community and the built environment.

The addition of public health performance measures in transportation plans provide a direct perspective on addressing community development, however few state and regional planning agencies incorporate these measures into their plans. Massachusetts, North Carolina and Texas are some states that use Health Impact Assessments (HIAs) to address public health in transportation planning. As more state DOTs and other transportation planning agencies gather additional data, the hope is that decision makers can develop applicable performance measures that are meaningful to reaching goals for addressing public health through transportation development.

PART II: Criteria for Assessing Strength of Sustainability Measures for Transportation

Performance measures are always an imperfect reflection of actual performance. The devil is very much in the details of how goals are captured. Different approaches have offered criteria for making sense of and using performance measures. In this section, we review three such approaches, and apply these criteria to the measures of transportation sustainability we identified in our survey of state DOTs.

Criteria 1: Traditional Transportation Criteria

Transportation agencies focus on measures that assess the core business, such as highway conditions. However, as the mission of transportation agencies has broadened from highway construction to operations and maintenance, other performance measures for economic development and customer satisfaction are increasingly used and effective (Cambridge Systematics, Inc. 2008).

There are five "traditional" criteria for selecting performance measures for transportation: 1) simplicity; 2) objectivity; 3) availability of data; 4) cost; and 5) controllability (Cambridge Systematics, Inc. 2008). Performance measures that hold public agencies accountable to the public and stakeholders should be simple and easy to understand. The measures should be based on factual results to avoid subjective data being interpreted in multiple ways, thus creating confusion or misinterpretation. The data should be reasonably easy to obtain, and preferably from within the organization. The cost of data collection should be consistent with the capacity of the agency. Finally, the selected measures should be within the agency's control.

Criteria 2: UN Sustainability Criteria

This set of criteria recognizes sustainability as a multidimensional concept not only referring to the environment, but also to social equity and economic development (Zietsman et al. 2011). According to *Sustainable Transport Evaluation* prepared by the United Nations (UN), a good measure of sustainability consists of three key elements: 1) it covers all dimensions of sustainability; 2) it corresponds to the underlying goals of sustainability (in this case goals for sustainability in transportation); and 3) should incorporate both qualitative information and quantitative data (Bongardt et al. 2011).

Criteria 3: Public Management

An influential set of criteria developed by public management scholar, Geert Bouckaert, identifies three standards: validity, legitimacy, and functionality (Bouckaert 1993). Traditionally, performance measurement systems only take into account validity which is inconsistent with the evolving nature of performance measurement. Bouckaert argues these conditions must shift simultaneously to keep performance measures in sync with management goals.

Validity

Validity refers to the internal strength of a mechanism, a theory, a system, or a classification. Therefore, a valid measure is one that is "sound, cogent, convincing, and telling" (Bouckaert 1993). More specifically, validity refers to technical requirements such as reliability and

transparency. It should reflect whether government is a producer of a service, or merely monitoring it. Data are more valid when they allow for comparisons of best practices. Bouckaert cautions against selecting measures merely because they are available (though that reduces transaction costs), but instead to focus on what are desirable measures. The users of data may also use their experience to distinguish between data quality rather than assuming that all metrics are equally helpful in explaining outcomes.

Legitimacy

Bouckaert makes the case that legitimacy of measures is not just a technical quality, but one tied to how the measures engage organizational actors. To that end, two shifts must occur for a performance measurement system to attain legitimacy. First, the system must shift from a closed system (internal) to an open system (internal and external). Second, the system must shift from a top-down to a top-down and bottom-up system (Bouckaert 1993). Internal openness means that middle- and lower-level management are involved, thereby enhancing commitment. External openness refers to making information accessible to stakeholders. Since one reason for measuring performance is to increase accountability, it is crucial to share information with the public. Whether the public considers the measurement system as efficient or not serves as an essential element in determining the legitimacy of the organization (Bouckaert 1993).

Functionality

Finally, functionality occurs when there is cohesion between the measures in a measurement system and the organization. Functionality requires that an organization shift from a “naïve belief in neutrality” to an awareness of possible dysfunctionality of measures. The core mission of achieving functionality is to improve the measures and measurement in order to increase functions and decrease dysfunctions. Measures that may threaten or fail to support the purpose of the organization should be eliminated (Bouckaert 1993).

Part III: Model Environmental Sustainability Performance Measures

We took a two-part approach to evaluating environmental sustainability performance measures. First, we identified five thematic areas that were most commonly used to assess performance. We believe that the high frequency of some measures' use is indicative of their value, and that evaluating the five, common sustainability performance measure themes will help DOTs decide if these common measures are appropriate for their own use. The second half of the evaluation focuses on one performance measure used by the Oregon DOT (ODOT) that is unique and innovative relative to other more common measures. Evaluating this unique and non-traditional measure will help DOTs assess whether greater creativity could be employed in developing measures that can more specifically assess sustainability in transportation systems. Furthermore, it will help identify benefits and drawbacks of using measures not included in the five common themes.

Common measures will be evaluated using two sets of criteria. First, we use the "traditional" metrics of simplicity, objectivity, easily collected data, cost, and the idea that the agency should have control over the conditions measured. We then compare the measures against the UN's recommendation that sustainability measures cover the three dimensions of sustainability (i.e., economic, social, and environmental). The unique and innovative measure will be evaluated using the two systems above as well as Bouckaert's criteria of validity, functionality, and legitimacy, which require greater insight into how the organization uses the measure.

Table 3. Criteria for Evaluating Strength of Sustainability Performance Measures

Criteria Set	Type or Performance Measures	
	Common	Unique or Innovative
Traditional Criteria • Simple • Objective • Easily measured • Low cost • Within control of agency	X	X
UN Sustainability Criteria • Economic sustainability • Social sustainability • Environmental sustainability	X	
Public Management Criteria • Validity • Legitimacy • Functionality		X

To structure our evaluation of common measures, we developed the five thematic areas that capture most of the performance measures mentioned by states discussed earlier. Theme 1, recycled materials, refers to measures that monitor the amount of pavement, concrete, and other raw materials that the DOT either reuses in its own projects or extracts from its waste stream for use elsewhere. Theme 2, alternative fuels, refers to measures that monitor the number of alternative fuel vehicles in the DOT fleet, the amount of alternative fuels consumed by the DOT's fleet, or the percentage of fuel demand supplied by alternative fuels. Theme 3, emissions and air quality, was broken down into three sub-themes. Some states track emissions strictly from DOT vehicles, while some track the transportation system's emissions as a whole, and California considers the *entire* state's emissions (transportation and otherwise) as a performance measure. Theme 4, resource usage, refers to measures tracking resource (paper, water, electricity) usage by the DOT. This category *does not* include vehicle fuel usage, which is kept in theme 2. Finally, theme 5 refers to measures that track habitat preservation or restoration as a part of DOT activities.

Theme 1: Recycling

These measures monitor the amount of asphalt, concrete, and other construction materials that the DOT either reuses in its own projects or extracts from its waste stream for use elsewhere.

Traditional Criteria. Recycling measures tracking tons of pavement recycled (used by Florida, Missouri, Oregon, and Wisconsin) are good examples of traditional performance measures, albeit ones that may not meet all of the requirements of full sustainability. Recycling measures appear to comply with the traditional criteria. Recycling measures are based on simple quantities of recycled material, easily measured through tipping fees by the ton or truckload. They are objective, as there is no doubt as to what constituted a recycled material. Data is relatively easy and inexpensive to collect at the project level, and the amount of materials recycled is within the DOT's control.

UN Sustainability Criteria. Recycling of infrastructure materials, either for reuse in future projects or for diversion from the DOT waste stream, covers two of the three requirements of a fully sustainable measure. Recycling indicators touch upon environmental sustainability in that recycling can prevent extraction of virgin material, and the potentially negative environmental externalities associated with resource extraction. This measure also touches upon economic sustainability as recycling measures and use of recycled material are tied to efforts to reduce material costs for the DOT. The measures fail to touch on social sustainability, as there is not an immediate connection between use of recycled pavement material and social welfare. It should be noted that just because this measure covers environmental and economic sustainability, it does not mean that recycling is an inherently sustainable practice. Since recycling asphalt uses less energy and costs less than new material, the practice of utilizing recycled materials is sustainable.

Theme 2: Alternative Fuels

Alternative fuel measures refer to the percentage of agency's fleet vehicles that use alternative fuels, the statewide number of alternative fueled vehicles, or the agency's consumption of

alternative fuels within a given time period. In the context of transportation agencies, alternative fuels are any fuels *except* gasoline and diesel.

Traditional Criteria. The measures in this category that assess the agency's vehicle fleet meets all five criteria. However, measures for all vehicles statewide meet only four by failing the criterion for control of the measure. For example, Louisiana measures the percent of state and local fleet using alternative fuels, Hawaii calculates percent of newly purchased automobiles using alternative fuels, and Oregon uses total biodiesel use as percent of total diesel consumption. The decision of individuals and companies to purchase alternatively fueled vehicles is not within the control of a state agency. Those measures are certainly relevant transportation facts but they are not useful for assessing agency performance.

The measures meet the other four traditional criteria. Alternative fuels are easy to measure and simple to understand. Moreover, these measures are based on hard facts, so they are easily agreed upon among various stakeholders. Since all vehicles are registered, the number of alternatively fueled vehicles in that state can be determined. Therefore, the cost of data collection could be relatively low.

UN Sustainability Criteria. This category of measure has the *potential* to meet all the requirements for a suitable sustainability measure. Alternative fuel use is usually motivated by adesire to reduce GHG emissions, a key aspect in environmental sustainability. Adoption of alternative fuels is also driven by economic considerations. As traditional gasoline and diesel costs continue to fluctuate, alternative fuels, like natural gas, are seen as more affordable alternatives for fuel-hungry DOT fleets when traditional fuel costs are high. Therefore, this measure covers economic sustainability. Coverage of social sustainability is less certain, as it depends on whether or not the DOT considers reducing harmful emissions associated with traditional fuels to be part of their social goals. One could argue that use of alternative fuel technology contributes to technology development, adoption, and market penetration leading to greater reduction in emissions.

Theme 3: Air Quality and Emissions

Air quality and emissions measures track transportation-related emissions both regionally and in the state as a whole. Generally, two forms of emissions are tracked, 1) greenhouses gas (GHG), like CO2, and 2) emissions affecting air quality, like nitrous oxides (NOX) and volatile organic compounds (VOCs). DOTs are also tracking emissions by both fleet assets and fixed assets, like buildings.

Traditional Criteria. This category of measure meets four of the five traditional criteria, with the exception of being easy to measure consistently. For example, Oregon DOT measures total GHG emissions from its building, energy, transportation and solid waste sources. This is a simple measure and based on real facts; each state has the greenhouse gas inventory. Therefore, data is directly available and the cost of collecting it is low. This measure is also directly under the control of the DOT, since they can determine how to reduce emissions from their own buildings. However, the measurement and tracking of greenhouse gas emissions can be more difficult. For example, in order to determine if there has been progress toward emissions reductions, states need a baseline to make comparisons across different time periods. This requires that the measurement be consistent and standardized.

UN Sustainability Criteria. This category of measure meets the UN's standards for sustainable performance measures. Tracking both greenhouse gases as well as air pollutants can help inform reduction of both types of emissions, making these measures relevant to environmental sustainability. Air pollutants like NOX and VOCs also have significant negative impacts on public health, which makes these measures highly relevant to social sustainability. Finally, recording and reporting air quality measures is required for some forms of FHWA funding, so these measures meet the requirement for economic sustainability in the context of the DOT.

Theme 4: Resource Consumption

Resource consumption measures refer to measures that track resources *other than fuel and construction materials* that the DOT uses. Common resource usages that agencies measure include water, electricity, paper, and road salt.

Traditional Criteria. This category of measure meets all the traditional criteria. The example presented here is the paper usage measure used by ODOT. In order to reduce the amount of paper waste, ODOT measures total numbers of boxes of paper purchased by them and the weighted average of post-consumer recycled content of paper purchased, reduction in costs to print plans and specifications, and percentage of total bids received electronically. These measures are simple and objective. Moreover, they can be measured easily at a low cost since all operations are within the agency. Finally, these activities are directly within the control of the agency as they can decide how much paper will be purchased and initiate a paperless policy to reduce paper use.

UN Sustainability Criteria. These measures meet the requirements for environmental and economic sustainability measures, but their measure of social sustainability is uncertain. Reduced material consumption is a key component of sustainability, so tracking DOT resource use easily meets the requirement for environmental sustainability. Reduced usage usually has an impact on the operating costs of the agency as well, so these measures are appropriate economic sustainability indicators. However, there is not a clear connection between social sustainability and the types of resource usage tracked by these measures, so we cannot say that resource measures meet the requirements for social sustainability.

Theme 5: Wildlife and Habitat Considerations

Five states currently track measures that relate to wildlife habitat or ecosystem. These measures include acres of wetland impacted by roadway projects and acres of wetlands restored.

Traditional Criteria. This measure meets three of the traditional criteria. For example, Maryland DOT measures the percentage of land outside areas planned for growth, development and sewer service that is permanently preserved by federal, state or local programs. This measure is simple to understand and it is based on facts, so it meets the criteria of simplicity and objectivity. It is relatively easy to track and measure. However, this measure is not directly under the DOT's control since other agencies, such as the Department of Agriculture, are also involved. In addition, tracking and calculating the measure may be costly if field work is required to measure total wetland acreage.

UN Sustainability Criteria. This theme meets the requirements for environmental sustainability, but may not meet the requirements for social or economic sustainability. Preservation of natural space helps maintain the ecosystem services like flood control and carbon sequestration associated with open land and makes this measure relevant to environmental sustainability. These measures are less relevant to economic sustainability, as habitat restoration or open space preservation often requires additional money and is outside the core business of a transportation agency. At the same time, there is no clear or immediate link between this measure and any social outcomes relevant to the DOT, so it does not meet the requirements for monitoring social sustainability.

Table 4 summarizes the results of the evaluation of each group of common measures.

Table 4. Evaluation of commonly used environmental sustainability performance measures

Criteria Set	Criteria	Meets Criteria				
		Recycling	Alternative Fuels	Air Quality and Emissions	Resource Consumption	Habitat Preservation
Traditional	Simplicity	Yes	Yes	Yes	Yes	Yes
	Objectivity	Yes	Yes	Yes	Yes	Yes
	Data Availability	Yes	Yes	No	Yes	Yes
	Low Cost	Yes	Yes	Yes	Yes	No
	Controllability	Yes	No	Yes	Yes	No
UN Sustainability	Social Sustainability	No	Uncertain	Yes	Uncertain	No
	Economic Sustainability	Yes	Yes	Yes	Yes	No
	Environmental Sustainability	Yes	Yes	Yes	Yes	Yes

A Unique and Innovative Measure: Percent of Urban Roads with Sidewalks and Bikeways

Several state sustainability performance measurement systems include measures that are not easily categorized into one of the five themes analyzed above. Such measures are considered unique and innovative, as they attempt to measure transportation performance in more specific and potentially less intuitive ways. In this section, we focus on a unique measure adopted by the

Oregon Department of Transportation (ODOT) in its “Oregon Shines” benchmarking program. This measure is: percent of urban roads with sidewalks and bikeways.

ODOT has a requirement under state statute to report on performance annually to the state legislature. The measure is itself not just interesting; it is also an example of a measure that is being actively used by decision makers. To assess its annual performance, ODOT uses an intradepartmental team to review, assess, modify, and implement new measures, which are approved by the ODOT Director and in some cases the state legislature under the budgeting process. To develop and redefine measures, ODOT attempts to engage experts, stakeholders, influencers, media, and others to achieve more outcome-based performance rather than just simple process measures.

According to ODOT Sustainability Program Manager, Geoff Crooks, the strength of ODOT’s system’s measures vary greatly from measure to measure. ODOT makes concerted attempts to ensure that measures reflect what they are intended to measure, which often requires redefining the measures, adding new measurement instruments, or even replacing an agency-wide measure that is not working. These changes can be due to several factors, including public perception, improvement of measurement tools, and emerging requirements (Crooks 2016).

ODOT’s unique and innovative measure, *percent of urban state highway miles with walkways and bikeways,* is intended to evaluate access to multi-modal transportation options in urban areas across the state. ODOT has established a number of criteria for this measure’s application. First, this measure is only applied to urban areas with populations over 5,000 where the population density meets federal definitions in the area bordering the highway. However, small, incorporated cities with populations under 5,000 are also included. Second, walkways must be present, five feet or more in width, and in fair or better physical condition. Bikeways are defined as marked bike paths with a width of five feet, a travel lane shared by people biking and driving where the posted speed is 25 MPH or less, or a multi-use path within the highway right-of-way. Using this measure, ODOT seeks to meet its goal of providing walkways and bikeways on 65% of highway roadside mileage in urban areas throughout the state by 2030 (Oregon DOT 2017).

Traditional Criteria. This measure meets four of the traditional criteria mentioned above. First, it measures the percent of urban roads with sidewalks and bikeways, which is simple and easy to understand by the legislature and the lay public (Crooks, 2016). Second, this measure is objective as it calculates the real number of urban roads based on hard facts rather than using subjective opinions. Third, the construction of walkways and bikeways on urban highways is under ODOT’s control. Therefore, ODOT can attempt to increase sidewalks and bikeways in order to meet the performance target. However, this measure does not meet the criteria of low cost and it is not very easy to measure. It costs the ODOT two years to physically inventory and evaluate all highways in urban area and small cities. After that, the inventory needs to be updated annually based on site visits, monitoring, and highway video logs, which reflect that high cost is associated with this measure (Oregon DOT 2017). Finally, the data used to measure the total urban roads with bikeways and sidewalks is readily available to ODOT, so this measure meets the criteria of data availability.

UN Sustainability Criteria. This measure meets the criteria for environmental and social sustainability, but whether or not it reflects economic sustainability is unclear. Provision of sidewalks and bikeways has the potential to reduce the modal share of personal automobiles.

Reducing automobile usage, and its higher associated carbon emissions is a means of achieving environmental sustainability. Providing alternate means of transportation for residents who cannot drive or afford a personal vehicle is often articulated as a social goal for DOTs, and can be thought of as meeting the criteria for a socially sustainable measure. This measure does not immediately reflect the economic cost or benefit associated with installation of pedestrian and bicycle infrastructure. Yet, pedestrian and bicycle options can be more cost-effective options among transportation users and could reduce costs in the long term. Therefore, this measure does not clearly meet the requirement for a measure of economic sustainability.

Public Management Criteria

Validity. As described previously, Bouckaert asserts a measure is valid if it is sound, cogent, convincing, telling, reliable, and transparent. ODOT's measure of the percent of urban roads with sidewalks and bikeways meets Bouckaert's criteria for a valid measure to some extent. However, due to changes in the measure's denominator (i.e., the total non-interstate highway miles in urban areas, incorporated cities, or areas that meet a certain density threshold), the measure's validity is often compromised. Crooks asserts, "As urban area boundaries expand, new formerly rural miles are added to the urban inventory, and these rarely if ever have bikeways or walkways when added. Furthermore, jurisdictional transfers to local governments occasionally remove highways from the urban inventory, which are typically fully improved routes with bikeways and walkways" (Crooks, 2016). For these reasons, there are years when ODOT has built additional walkway and bikeway miles but has seen the total percent in urban bikeways and walkways drop due to growth in this denominator. To enhance this measure's validity, ODOT might consider investigating means to stabilize the measure's denominator so nuances across jurisdictions do not compromise ODOT's final annual measurement.

Legitimacy. ODOT's measure of the percent of urban roads with sidewalks and bikeways meets the criterion of legitimacy, but to a limited extent. This measure was originally developed by an ODOT internal staff workgroup. Once this group finalized the measure, it was approved by the Oregon state legislature (Crooks, 2016). However, development of and revisions to this measure have not directly engaged external stakeholders. Therefore, this measure fails to shift from a closed, internal system to an open system of engagement. This measure has somewhat shifted from a top-down to a bottom-up system, as it was developed by DOT staff and subsequently approved by the state legislature, not vice versa. To better meet Bouckaert's criteria for legitimacy, ODOT should seek to engage a variety of external stakeholders, such as local residents and external transportation experts, as it plans for future revisions of this measure.

Functionality. According to Bouckaert, a measure is functional if there is cohesion between the measure and the organization. ODOT's measure of the percent of urban roads with sidewalks and bikeways meets the criteria, but again, to a limited extent.

According to Crooks, ODOT attempts to make all of its publicly reported measures align with the Department's defined goals, missions, and values, which are categorized as safety, mobility, preservation, sustainability, and stewardship. Specifically, this measure meets the categories of safety, mobility, and sustainability. Furthermore, ODOT acknowledges the dysfunctionality of this measure, which Bouckaert asserts is a requirement of functionality.

This measure is functional, but has several limitations. Specifically, the issue of the changing denominator has made understanding trends over time indicated by this measure difficult. Crooks also acknowledges there is a general desire to look at not just the completeness of ODOT's overall performance measurement, but whether ODOT is succeeding in closing the most critical walking and biking gaps throughout the state, which this measure does not address directly.

ODOT has developed a path towards improving this measure. It is nearing the adoption of its updated Oregon Bicycle and Pedestrian Plan, which includes efforts to improve performance measures. As part of this work, there will be an internal and external discussion, involving a greater variety of stakeholders, on whether this particular measure should be included as one of ODOT's key performance measures in the future.

Table 5 is a summary matrix of the evaluation of this innovative measure.

Table 5. Assessment of Uncommon Measure: "Percent of urban state highway miles with walkways and bikeways"

Criteria Set	Criteria	Meets Criteria	Rationale
Traditional	Simplicity	Yes	Well understood by stakeholders.
	Objectivity	Yes	Based on facts.
	Data Availability	Yes	Data is readily available to ODOT staff.
	Low Cost	No	High opportunity costs.
	Controllability	Yes	Directly under ODOT's control.
UN Sustainability	Social Sustainability	Yes	Provides alternate means of transportation for residents who cannot drive or afford a vehicle.
	Economic Sustainability	Uncertain	High short-term costs. However, pedestrian and bicycle options can be more cost-effective options among transportation users and could reduce costs in the long-term.
	Environmental Sustainability	Yes	Can reduce automobile usage and carbon emissions.
Bouckaert	Validity	To an extent	Changes in the denominator can lower the calculated number of walkways and bikeways.
	Legitimacy	To an extent	ODOT did not initially engage external stakeholders.
	Functionality	To an extent	Functional but with limitations (i.e., changes in denominator).

Selection of Performance Measurement Tools

Apart from the metrics themselves, a number of states have experimented with different tools to measure and share sustainable transportation performance across states. Selection of the appropriate tool can often produce different performance outcomes and performance measurement system successes, which requires that states developing new sustainability performance measurement systems consider their options. For example, Illinois and New York use transportation rating scorecards to measure sustainable transportation practices, while other states have adopted strategic plans to guide sustainable transportation initiatives. Although different in design, both the scorecard and strategic plan approach have proven benefits among performance measurement initiatives.

A key value of performance scorecards is that they are accessible to both citizen consumers and governmental officials, as they "correct information asymmetries between organizations that provide services and citizens who consume services," while making service delivery organizations more "accountable" to citizens and public officials (Gormley 2004). Furthermore, performance scorecards can facilitate organizational change, as report cards directly shape the behavior of organizations that deliver services. For example, embarrassed by its poor rating, an organization might make a series of organizational changes to improve performance, hoping for a better outcome in the next round of performance evaluations (Gormley 2004).

Measuring performance through use of strategic plans is also found to effectively shift organizational processes. Tapinos et al. discovered that an organization's evaluation of performance measurement has significant influence in supporting the achievement of its organizational goals and the effectiveness and efficiency of its strategic planning process (Tapinos et al. 2005). Additional benefits of strategy-aligned performance measurement include an efficient means of communicating strategic priorities; creating a shared understanding; monitoring and tracking the implementation of strategy; encouraging behavior consistent with strategy; making clear links between the performance of individuals and sub-units, and sub-units and overall organizational performance; promoting integration among various organizational processes; focusing change efforts; and permitting and encouraging organizational learning (Johnston and Pongatichat 2008). Thus, developing a strategic plan for a DOT's sustainability performance measurement system can encourage widespread adoption of the system and assist in its permeation of the organization's overall activities and goals.

Part IV: Implementation of Performance Measures and Organizational Learning

Performance information is ultimately only going to make a difference to public outcomes if public officials—either elected officials or public managers—use it for day-to-day decision making. Thus, acknowledging that use of performance information must be purposeful and deliberate, not only by state DOT middle- and lower-level staff, but also by top-tier management, is essential to a sustainable transportation performance measurement system's success. This point may seem obvious, but it remains the greatest practical challenge for the implementation of performance measures for purposes of sustainability. As in other areas of governance, the use of information in transportation lags far behind the supply. To encourage purposeful use, especially of measures that challenge existing organizational cultural norms, transportation agencies need to adopt the techniques of a learning organization.

Purposeful Use

Purposeful use of performance information by public employees is a "central hope" of advocates for more use of performance measures (Moynihan 2009). Purposeful use includes using performance information to improve services through better-informed decisions, goal-based learning, or sanctioning and rewarding use (Kroll 2015). In his study on the use and nonuse of performance data in decision making, Kroll identifies two important characteristics of purposeful performance information use: first, performance information is considered more than just financial data and has a specific focus on the results and achievements of public administration; second, performance information is available in a quantitative, aggregated format, and is made transparent through reports or databases. It is not collected on an ad hoc basis, but follows a systematic control-cycle logic where indicators for goal achievement are defined, performance information is collected and analyzed, and it is purposefully used for future decision-making (Kroll 2015).

Kroll (2015) identifies empirical studies of performance information use across a range of policy areas to identify what factors predict whether data will be used or not for public sector decision making. Studies show that measurement system maturity and stakeholder involvement are the two most prominent drivers of purposeful use. More sophisticated and mature measurement systems, which go beyond simple production of raw data, make information use more likely because they provide a good range of different data, align the reporting to the demands of the addressees, link information to goals and strategic plans, and offer benchmarks. Achieving a mature measurement system will require time and consistent commitment from state DOT leadership and staff, but will contribute to the system's robustness in the long term. Additionally, Kroll cites involvement of external stakeholders as critical to the success of a performance management system, as they encourage managers to take performance information seriously and can help make sense of numbers or in identifying meaningful indicators (Kroll 2015). Thus, involving federal and local government partners, elected officials, DOT managers, contractors, and front line staff is critical to developing an effective sustainable transportation performance management system.

An additional important factor of purposeful use is leadership support. Top-level support trickles down the organization: managers who suspect organizational leaders are less committed to

reforms will gravitate to other problems and priorities (Kroll 2015). Thus, support for sustainability performance measurement systems must originate with state elected officials and top-tier DOT management. Without such support it will be seen as performance window dressing. Furthermore, the support capacity for performance management practices, which can be defined as the resources, capabilities, and technology available to make performance measurement work, is a key element of purposeful use (Kroll 2015). This element suggests that the success of a sustainability performance management system is highly dependent on how the system is adopted, and that early investments in its support can pay off in the long-term of the system.

Organizational Learning

Key to implementation of a performance measurement system is ensuring there is widespread commitment to the system's success. However, achieving commitment is difficult when the system's measures are nontraditional and not widely understood, as environmental and social sustainability currently are among many state DOTs. As a result, sustainability measures are not culturally embedded in most DOTs. Indeed, even the sustainability measures in place reflect this cultural tension. It is common to have a measure that meets either environmental and social sustainability, or environmental and economic sustainability, but few meet the requirement of social sustainability. Many measures are monitoring practices that are oriented primarily toward cost reductions, with environmental sustainability as a secondary goal. The neglect of social sustainability, and failure to meet full sustainability is not necessarily a fault of the measures or their creators, as they were primarily intended to measure economic savings or environmental sustainability, and many meet those goals. This emphasis on economy over environment or society is reflective of the fact that at most DOTs, there is a culture of efficiency or cost savings, but not a culture that embraces full sustainability, and full sustainability is often seen as tangential to their work. These measures are part of a bigger picture and it is hard for a single type of measure to capture all of the DOT's sustainability work. To get fully sustainable measures, DOT leadership must drive sustainability into the DOT's culture, a task that is described in the next section.

The importance of organizational culture to the use of knowledge is a central point in research on organizational learning. In order for state DOTs to create, retain, and transfer knowledge about these performance measurements, it is important that they engage in organizational learning. Organizations learn when they acquire, institutionalize and act on information. One basic distinction between types of learning is single-loop versus double-loop learning processes, as shown in Figure 1 (Argyris and Schon 1995). In government, single-loop learning is appropriate for routine, repetitive operations where goals are widely accepted. In results-based reforms, single-loop learning implies specifying goals that are measurable, tracking the achievement of goals, and judging the results in the context of a point of comparison (e.g., pre-set targets, previous performance, or the performance of other organizations). In comparison, double-loop learning occurs in government when public actors test and change the basic assumptions that underlie their mission and key policies. In results-based reforms, double-loop learning implies a willingness to revisit the basic organizational mission, goals, and strategies on a regular basis (Moynihan 2005).

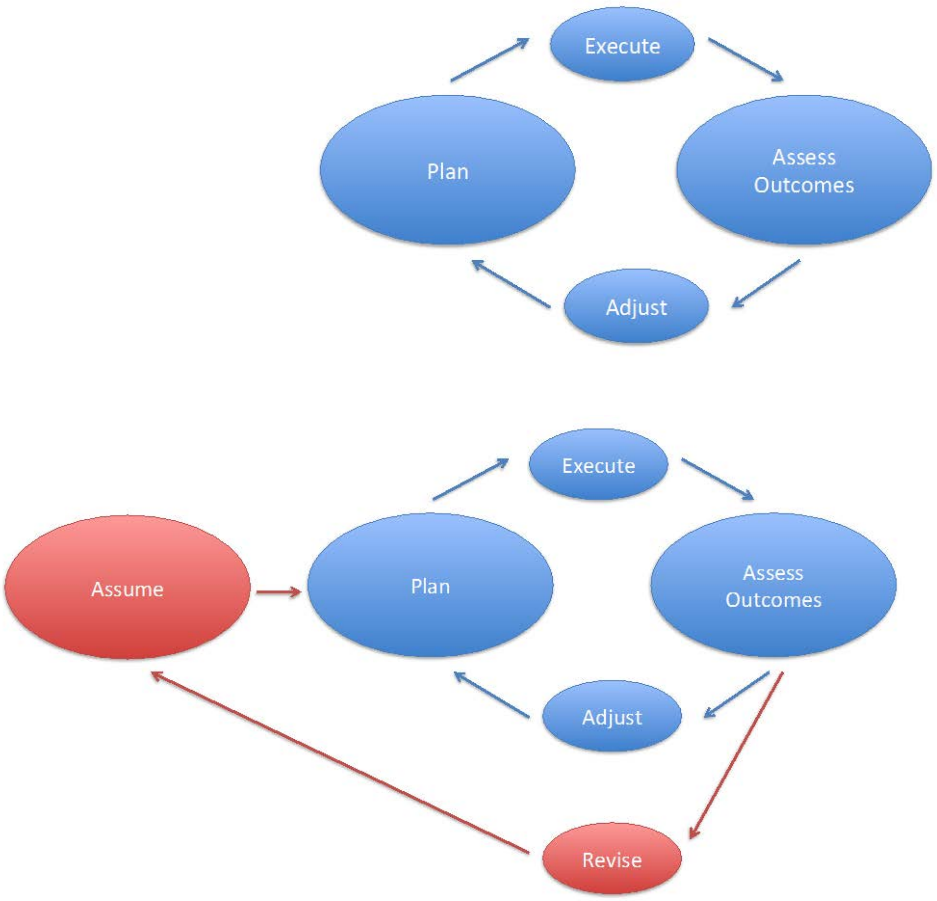

Figure 1. Single-Loop (top) and Double-Loop (bottom) Learning Processes

Because sustainability measures are often a challenge to existing norms in DOTs, their use implies a form of double-loop learning. Such learning would require staff to reassess the underlying assumptions of current transportation programs and recognize environmental sustainability as a key priority. Such learning is uncomfortable because it implies challenging widely accepted norms about the purpose of the organization. State DOTs must develop a plan for an environmental sustainability performance measurement system, execute the plan, assess the outcomes, and revise the plan if expectations concerning sustainability are unmet.

The Oregon DOT is an example of an organization that has successfully engaged in organizational learning to achieve prioritization of sustainability measurement, and to assess and redefine measures when they become ineffective. For example, ODOT evaluates key measures in its sustainable transportation performance measurement system, identifies limitations, and proposes improvements to specific measures every two years (Crooks, 2016). Overall, a double-loop learning process has helped ODOT ingrain environmental sustainability measurement into its organizational culture by questioning the goals of existing state transportation programs and projects and asking whether they are actually worth pursuing with or without sustainability measures. There is a need for additional examples of such patterns of organizational learning around sustainability measurement.

Conclusion

While the purpose of transportation has historically been to provide safe and efficient movement of people, goods, and services, changes in land-use development, demographics, and sustainability initiatives have resulted in complex challenges to designing new, as well as adapting existing, transportation networks. As a result, the USDOT has adopted two non-traditional performance measures—Quality of Life in Communities (livability) and Environmental Sustainability—to adapt to such changes and shape future transportation networks. USDOT has created a flexible framework with limited guidance. In doing so, it has given states and regions the ability to develop strategies and measures as they see fit, but has also resulted in variable use and types of performance measures and ultimately inconsistencies in performance evaluation across the country.

The fact that sustainability is such a broad and complex concept and the difficulty related to measuring livability are also factors limiting the development of performance measures despite states and regional planning agencies embracing the concepts. For example, transit programs reduce reliance on inefficient automobiles while also providing improved mobility to disabled, elderly and low-income individuals. In effect, many transportation agencies' policies can be viewed as socially and environmentally sustainable policies, and can be used as a starting point for the development and adoption of a sustainable transportation performance measurement program. Sustainability and performance management are increasingly politically relevant topics, and not just in the transportation world. Current examples on the international stage include the prominence of transportation and the sustainability theme within the World Economic Forum's Annual Global Risks Reports and also the UN's focus on transport's role as "necessary" and "vital" to achieving its 17 Sustainable Development Goals. At the national level, USDOT's FHWA created the INVEST Tool to encourage discussion, self-reflection, and sustainable practices by providing a method for practitioners to self-evaluate their transportation planning, projects, and operations and maintenance activities, while the U.K. based CEEQUAL sustainability assessment, rating, and awards scheme can be used during the development, design, construction, and operation stages of civil engineering, infrastructure, landscaping, and other public space projects. The state of California passed legislation in 2008 integrating future land-use planning with that of transportation planning efforts in order to reduce the greenhouse gas emissions produced by the transportation system.

There is consensus that transportation systems influence community development and quality of life, especially as communities grow and use of land changes. However, the current challenge in identifying performance measures for livability comes from being able to differentiate between social sustainability and livability. Additionally, it is challenged by the fact that transportation planners are moving away from a mobility-based approach, focused on speed, flow, and capacity on highways and arterials, to an approach based on accessibility, focused on addressing proximity to trip origins and destinations via sidewalks, bicycle paths, and public transportation stations. In general, the performance measures used by state and regional transportation agencies related to livability can be categorized into five groups: safety, access/connectivity, active transportation, equity, and public health. Examples of specific measures identified include: the average number of jobs in proximity of residence; percent of urban roads with walkways and bikeways; and housing units in proximity to public transportation.

Analysis of state and regional transportation plans reveal a few common trends. One, even though Long-Range Transportation Plans address social sustainability and livability, indicators of performance are presented in economic and environmental terms, such as cost per benefit or amount of delay, that do not directly relate to livability. Instead, the limited information on livability performance is most often housed within alternative transportation plans, such as bicycle and pedestrian plans, transit plans, and multi-modal plans, and addressed via progress made toward increasing existing roadways' compatibility for bicycling and walking or the ability to incorporate *Complete Streets*. Two, there is a lack of performance measures attributing to public health, which is usually addressed as a subset to other themes and not necessarily a stand-alone theme, even though the addition of public health performance measures within transportation plans provide more of a direct community development perspective.

While the majority of states have yet to utilize performance measures related to environmental sustainability, a multi-pronged search of state DOTs showed 18 states and the District of Columbia have currently adopted performance measurement systems related to environmental sustainability, resulting in a total of 88 measures. The current measures generally monitor five broad, common categories: 1) usage of recycled materials (e.g., recycled pavement), 2) usage of alternative energy sources, 3) air quality and emissions, 4) agency energy and resource consumption, and 5) land use or habitat preservation. A unique and innovative measure, *the percent of urban roads with sidewalks and bikeways*, was also identified as being utilized by the Oregon DOT. Implementation of successful sustainable transportation measurement systems in state DOTs can be done with assistance from the three criteria sets applied in our analysis. While the measures we evaluated did not directly meet all requirements of their respective criteria, these criteria help state DOTs develop potentially stronger measures than those analyzed here. Regarding the traditional criteria, sustainable transportation measures should be simple, objective, easily measured, low cost, and controllable. Of the UN sustainability criteria, sustainable transportation measures should meet the three dimensions of sustainability: economic, social, and environmental. Finally, of public management criteria, sustainable transportation measures should be valid, legitimate, and functional. Adhering to these criteria will help develop widespread prioritization of sustainable transportation systems, and also assist state DOTs to achieve the overarching goal of sustainable transportation, ensuring that present transportation needs are met without compromising the ability of future generations to meet their transportation needs.

Performance information will make a difference only if it is used purposefully to improve transportation services through better-informed decision making and goal-based learning. At the same time, the challenge of ensuring the data are actually used remains. To overcome this, support for environmental sustainability and livability performance measurement systems must originate with top-level leadership (state elected officials and DOT management) and then trickle down throughout the organization. Purposeful and committed use however is not the sole responsibility of leadership, but rather a team effort involving all transportation stakeholders including DOT staff, contractors, and other federal and local government partners. Transportation agencies may find the use of rating scorecards and/or strategic plans beneficial. Performance scorecards are of value as they are accessible to both citizen consumers and government officials, and can facilitate organizational change as they shape the behavior of the transportation agencies themselves. The use of strategic plans can encourage adoption of the performance system and ingrain its goals throughout the organization.

Ultimately, due to the non-mission based nature of livability and environmental sustainability within DOTs, a change in culture away from transportation's civil engineering roots and toward a foundation of systems thinking that creates a less expensive, less resource and carbon intensive, and more accessible transportation system is needed. Leadership looking to drive this cultural change into their transportation agencies should require staff to reassess the underlying assumptions of current transportation programs and recognize livability and environmental sustainability as key priorities (the double-loop organizational learning process) on a continual basis. Also, leadership should focus on expanding the agencies' scope beyond just infrastructure projects to include transportation services and measures that place its role within the social, environmental, and economic systems that form the basis of our society.

Appendix A: Existing Environmental Sustainability Performance Measures

Table 6. Sustainability Measures at U.S. State Transportation Agencies

State	Measures
California	• Amount of land changed from agricultural to urban use in acres (This data is reported by the California Department of Conservation in the Farmland Field Report and online database of the Farmland Mapping and Monitoring Program. This information is available on a biennial basis by county.) • CO_2 emissions reduction per capita • Vehicle Miles Traveled per capita http://www.catc.ca.gov/programs/STIP/2016_STIP/Adopted_2016_STIP_Guidelines.pdf (p. 8-10;42-45) http://www.dot.ca.gov/hq/tpp/offices/ocp/ATLC/documents/august_15_2013/document_links/indicator.pdf (p. 17) http://www.dot.ca.gov/hq/tpp/californiatransportationplan2040/final-draft-ctp2040/docs/ctp2040-final-draft-appendix-1-022316.pdf
Delaware	• Acres of preserved space (land within Agricultural Preservation District; landowners agree to not develop their land for at least 10 years, verify this definition with agency) • Vehicle emissions per capita https://www.deldot.gov/information/pubs_forms/delrtp/delrtp_102510.pdf (p. 31) http://www.deldot.gov/information/projects/us113/pdf/No8-Agricultural.pdf
Florida	• Emissions trends for motor vehicles (CO_2 etc.) • Number of projects screened through efficient decision making process (EDTM): EDTM takes place during planning process and involves collaborating with environmental resource agencies to avoid, minimize, and mitigate environmental impacts of projects • Tons of pavement recycled • Number of alternative fuel vehicles in FDOT fleet • Miles of FDOT-constructed noise barriers • Number of wildlife crossings • Vehicle Miles Traveled • Percent of travel severely congested (daily) http://www.dot.state.fl.us/planning/performance/2014/2014PerformanceReport.pdf http://www.dot.state.fl.us/planning/performance/MAP-21/2015MAP-21PerformanceReport.pdf
Hawaii	• Percent of new cars purchased that use alternative fuels http://www.hawaii2050.org/images/uploads/Hawaii2050_Plan_FINAL.pdf
Illinois	• I-LAST voluntary scorecard for evaluating sustainability of projects http://www.eastsidehighway.com/wp-content/uploads/2014/05/I-LAST-Version-2-DRAFT.pdf

State	Measures
Louisiana	• Percent of fleet on alternative fuels • Percent of state and local fleets on alternative fuels • Acres of wetland impacted by DOT projects • Number of parishes that meet mobile source emissions standards http://wwwsp.dotd.la.gov/Inside_LaDOTD/Divisions/Multimodal/Transportation_Plan/2015_Statewide_Transportation_Plan/02_Vision,%20Goals,%20Objectives,%20and%20Performance%20Measures.pdf
Maryland	• Transportation Emissions Reduction Measures (TERMs): commuter operations and ridesharing center, employer outreach (including employer outreach for bicycles), integrated rideshare, guaranteed ride home, telework resource center, mass marketing, MTA college pass, MTA commuter choice Maryland pass, and transit store in Baltimore • Transportation-related emissions by region (tons of VOCs, NOX, precursors of ozone emitted per day for an average weekday from transportation sources in the Baltimore and DC regions) • Transportation-related greenhouse gas (GHG emissions: CO2, CH4, NO2, CO, NOx, and VOCs) • Acres of wetlands or wildlife habitat created, restored, or improved since 2000 (cumulative tally of total acreage), Maryland Port Administration • TERMs • Number of MTA operated park-and-ride spaces • Compliance rate and number of vehicles tested for Vehicle Emissions Inspection Program (VEIP) vs. customer wait time • Acres of wetlands restored and miles of streams restored (Maryland State Highway Administration) • Total fuel usage of the SHA light fleet • Number of SHA park-and-ride spaces http://www.mdot.maryland.gov/Office_of_Planning_and_Capital_Programming/Dashboard/Documents/2013_AR_Updated_022013.pdf
Massachusetts	• Greenhouse gas emissions from MassDOT fixed assets • Greenhouse gas emissions from MassDOT fleets • Facility water consumption • Energy use by MassDOT fixed assets • Energy use by MassDOT fleets • Weather normalized salt usage • Average energy used per passenger trip on the MBTA transit system • Electricity generated by renewable resources on MassDOT properties as a fraction of MassDOT electricity consumption • Area of land transferred for recreation/conservation • Ratio of warm mix asphalt to hot mix asphalt on MassDOT projects • Installed capacity of renewable energy generation on MassDOT assets • Expenditure on environmentally preferable goods and services • Completion of facility audits and upgrades under the Accelerated Energy Program

State	Measures
	• Number of hybrids and plug-in vehicles purchased • Nominal fuel efficiency of new on road non-revenue vehicle purchases • Efficiency of new revenue vehicles • Number of electronic Registry of Motor Vehicles transactions https://www.massdot.state.ma.us/Portals/0/docs/GreenDOT/GreenDOT_Performance_Structure.pdf
Missouri	• Fleet usage and fuel efficiency • Number of tons of recycled material • Number of environmental warnings and violations received • Number of storm water runoff violations received http://www.modot.org/about/documents/April2016Tracker.pdf
Nebraska	• Percent of environmental commitments in compliance with NEPA • Post-consumer recycle content (Raw material in tons, recycle content raw material in tons, and percent post-consumer recycle content (material removed during highway construction or maintenance work that is available for reuse) • Corrective actions related to environmental commitments for construction projects completed within seven days http://www.transportation.nebraska.gov/docs/annual-report.pdf
New Hampshire	• Percent operations facilities in compliance with environmental regulations • Tons of salt usage (5-year moving average) • Energy usage of NHDOT facilities (measured in kbtu) • Energy usage of NHDOT vehicles (measured in gallons of fuel) https://www.nh.gov/dot/media/documents/2015-annual-report.pdf
New York	• Green Leadership in Transportation Environmental Sustainability (GreenLITES) rating program (self-certification program for transportation projects) https://www.dot.ny.gov/programs/greenlites
North Carolina	• Average statewide environmental compliance score (average score of all construction and maintenance projects statewide as inspected and evaluated by the Sedimentation and Erosion Control Program) on construction and maintenance projects http://www.cte.ncsu.edu/accountability/documents/blueprint/Full-Blueprint-Framework.pdf http://www.ncdot.gov/download/performance/2015_NCDOT_AnnualReport_web.pdf
Oregon	• Number of priority culverts that need work to improve fish passage • Percent urban state highway miles with bike lanes and sidewalks • Percent ODOT sustainability performance measures maintaining steady or trending positive • Total greenhouse gas emissions from ODOT's building, energy, transportation (fuel) and solid waste sources • Building energy use: Electricity use per square footage of leased and owned buildings and renewable energy as a percentage of electricity grid mix

State	Measures
	• Fleet fuel use: Total biodiesel use as percent of total diesel use • Waste Minimization and Recycling: recycling rate and total waste volume in major facilities • Paper Use: Total number of boxes of paper purchased by ODOT and the weighted average of post-consumer recycled content of paper purchases, reduction of DAS Copy Center costs to print plans and specifications, which also represent a reduction in charges to a project, and percentage of total bids received electronically • Percent of maintenance yards in compliance with the seven priority procedures of EMS • Hazardous materials: Amount of hazardous waste generated at each maintenance yard and truck shop • Water use at major facilities (gallons) • Total number of trucks using anti-idling technology • Hybrid, best-in-class high-mileage vehicles, and gasoline vehicles using alternative fuels as percent of all light-duty gasoline-powered vehicles • Percent of employees that participate in monthly transit pass payroll deduction program • Use of video conferencing and iLinc web conferencing for meetings • Percent of landscaping at new major facilities that include native or non-invasive plants • Percent of run-off being treated at major facility paved parking surfaces before being discharged into a stream of water • Index of access to alternative modes (walking, biking, and transit) from new major facilities • Percent of non-exempt new major facilities that meet high-performance standards (LEED or SEED) or equivalent in accordance with other state agency criteria http://www.oregon.gov/ODOT/SUS/docs/Sustainability_Report_2014.pdf https://www.oregon.gov/ODOT/CS/PERFORMANCE/Pages/PerformanceMeasureSummaries.aspx#Sustainability
Pennsylvania	See https://www.performanceplan.state.pa.us/Dashboard2014-15/Environment.pdf (too many PMs to list)
Washington	• Number of WSDOT storm water management facilities constructed • Cumulative number of WSDOT fish passage improvement projects constructed • Reduce transportation related greenhouse gas emissions from 44.9 million metric tons/year (projected 2020) to 37.5 million metric tons/year (1990) by 2020 • Reduce average emissions of greenhouse gases for each vehicle mile traveled in Washington by 25% from 1.15 pounds in 2010 to 0.85 pounds by 2020 • Increase the average miles traveled per gallon of fuel for Washington's overall passenger and light duty truck fleet (public and private) from 19.2 mpg in 2010 to 23 mpg in 2020 • Increase the number of plug-in electric vehicles registered in Washington from approximately 8,000 in 2013 to 50,000 by 2020 http://wsdot.wa.gov/publications/fulltext/graynotebook/Mar15.pdf

State	Measures
West Virginia	• Number projects delayed by environmental assessment http://www.transportation.wv.gov/highways/programplanning/planning/statewide/Documents/West_Virginia_Long_Range_Multi-modal_Transportation_Plan.pdf
Wisconsin	• Material recycling (tons of recycled materials used in projects) http://wisconsindot.gov/Documents/about-wisdot/performance/mapss/perf-report.pdf http://wisconsindot.gov/Documents/about-wisdot/performance/mapss/scorecard.pdf
District of Columbia	• Sustainable Tools for Assessing and Rating (STAR) Communities, Rating System http://www.starcommunities.org/rating-system/

Appendix B: Livability Performance Measures related to Sustainability

Table 7. Livability Performance Measures at U.S. State Transportation Agencies

State	Source Document	Livability Goal	Performance Measure/Indicator
Alabama	Transportation plans do not have performance measures that address livability		
Alaska	Transportation plans currently do provide performance measures for livability.		
Arizona	What Moves You Arizona? (LRTP) (2010-2035) [3]	Safety	# of Fatalities by Mode Choice
			# of Collisions by Mode Choice
	Bicycle & Pedestrian Plan (2013)	Safety	# of Fatalities with Bicycles (Statewide, State Highway System)
			# of Serious Injuries with Bicycles (Statewide, State Highway System)
			# of Fatalities with Pedestrians (Statewide, State Highway System)
			# of Serious Injuries with Pedestrians (Statewide, State Highway System)
		Access-Connectivity	# of Miles of State Highway System with Sidewalks (adjacent, parallel) or shared-use paths in urban areas, small urban areas
			# of Miles of State Highway System with paved shoulders meeting AASHTO guidelines for bicycles
		Active Transportation	% of Work Trips by Walking
			% of Work Trips by Bicycle
Arkansas	Transportation Plans do not provide performance measures for livability		
California	Strategic Management Plan	Safety	# of Work Zone-related Fatalities per Year
			# of Vehicle Travel Fatalities per 100M VMT
			# of Fatalities (Bicycle)
			# of Serious Injuries (Bicycle)
			# of Fatalities (Pedestrian)
			# of Serious Injuries (Pedestrian)

[3] Updates to Long Range Transportation Plan expected by early 2017

State	Source Document	Livability Goal	Performance Measure/Indicator
			# of Fatalities (Transit Modes)
			# of Serious Injuries (Transit Modes)
		Access-Connectivity	# of Complete Streets features on State highway system
		Public Health, Active Transportation	Per Capita VMT Reduction
		Active Transportation[4]	% Increase of Bicycle Travel
			% Increase of Pedestrian Travel
			% Increase of Transit Travel
	CalTrans LRTP 2040	Safety	# of Fatalities (Bicycle)
			# of Serious Injuries (Bicycle)
			# of Fatalities (Pedestrian)
			# of Serious Injuries (Pedestrian)
			# of Fatalities (Transit Modes)
			# of Serious Injuries (Transit Modes)
		Access-Connectivity	# of Complete Streets features on State highway system
		Public Health, Active Transportation	Per Capita VMT Reduction
		Active Transportation	% Increase of Bicycle Travel
			% Increase of Pedestrian Travel
			% Increase of Transit Travel
Colorado	2016-2017 Performance Plan	Safety	Fatality Rate per 100M VMT
	2040 Statewide Transportation Plan	Safety	# of Vehicle-related Fatalities
			# of Vehicle-related Serious Injuries
			Vehicle-related Serious Injury per VMT
			# of Bicycle Fatalities with vehicles
			# of Pedestrian Fatalities with vehicles

[4] California is expecting 200 to 300% increase in these measures by 2020

State	Source Document	Livability Goal	Performance Measure/Indicator
			# of Serious Injuries with Vehicles (Bicycle)
			# of Serious Injuries with Vehicles (Pedestrian)
		Access-Connectivity	Job Access with Reasonable Commute Times[5]
		Active Transportation	Transit Ridership (Statewide, Small Urban, Rural)
	Bicycle & Pedestrian Plan (2012)	Safety	# of Communities with Share the Road Program & policies
		Access-Connectivity	% of Public Lands with Bicycle, Pedestrian access
			% of Bicycle, Pedestrian networks completed
			% of State highways that are bicycle, pedestrian compatible
		Access-Connectivity, Active Transportation	% of Transit Stations that are Bicycle, Pedestrian accessible
			% of transit routes, systems that provide shared bicycles for the last mile connection
		Access-Connectivity, Active Transportation[6]	# of Employees commuting by bicycle
			# of Employees commuting by walking
		Access-Connectivity, Equity, Public Health, Active Transportation	% Medically Underserved Populations within ¼ mile of defined bicycle, pedestrian facility
			% of 65+ residents within ¼ mile of pedestrian facility
		Equity	# of Projects located in areas of underserved populations
		Access-Connectivity, Public Health, Active Transportation	% of Students that Bicycle, Walk to School
		Public Health	% change in Obesity Rate
		Public Health, Active Transportation	% Change in Mode Shift (from carbon-based vehicle miles)

[5] Could be considered economic sustainability indicator

[6] Through employee surveys

State	Source Document	Livability Goal	Performance Measure/Indicator
		Active Transportation	% of Transit Vehicles with Bicycle Accommodations
			% of Transit Stations with Bicycle Parking
			% Scenic Byway miles that are Bicycle, Pedestrian compatible
Connecticut	CTDOT Performance Measures	Safety	Highway Fatalities per 100M VMT
			Highway Fatalities per 100k Persons
		Active Transportation	Transit Ridership (New Haven, Shore Line East, CTtransit)
	Statewide Bicycle & Pedestrian Plan (2009)	Public Health	Reduced Vehicle Pollutants from Vehicle to Walking
			Reduced Vehicle Pollutants from Vehicle to Bicycle
		Active Transportation[7]	VMT Reduction per Weekday (Bicycle)
			VMT Reduction per Year (Bicycle)
			VMT Reduction per Weekday (Pedestrian)
			VMT Reduction per Year (Pedestrian)
	State Rail Plan	Active Transportation	# of Rail Passengers (New Haven, Shore Line East)
	State Highway Safety Plan (2016)	Safety	# of Drivers in Fatal Collisions per 100k Licensed Drivers
			# of Drivers in Serious Injuries per 100k Licensed Drivers
			Bicyclists Killed and Injured per 100k (Bicycles)
			Fatality Rate per 100k (Pedestrian)
			Non-Fatal Injury Rate per 100k (Pedestrian)
Delaware	Long Range Transportation Policy (2010)	Active Transportation	% of Trips by Non-Vehicle Modes
			% in Transit Ridership
		Access-Connectivity	Average # of Jobs within 15 minutes of residence
Florida		Safety	Fatality Rate per 100M VMT

[7] Based on 261 weekdays per year

State	Source Document	Livability Goal	Performance Measure/Indicator
	2015 Performance Report		Rolling Averages for Pedestrians
			Rolling Averages for Bicyclists
			Fatality Rate by Mode Choice
			Serious Injuries by Mode Choice
		Access-Connectivity, Active Transportation	Change in # of Bicycle and Pedestrian Facilities
			Change in Sidewalk Mileage in Urban Areas
		Equity	# of Annual Disadvantaged Trips
		Active Transportation	Change in Public Transit Ridership
			Ratio of Transit Ridership to Population Growth
			Change in Aviation Passenger Boardings
			Change in Seaport Passenger Trips
			Change in Annual Rail Passenger Trips
Georgia	2040 Statewide Transportation Plan	Access-Connectivity	% of Population Accessible to Transit
Hawaii	Statewide Pedestrian Plan	Safety	# of Annual Collisions with Pedestrians
			# of Annual Fatalities with Pedestrians
		Access-Connectivity	% of Complete Roadway Projects with Pedestrian facilities improvements
			Miles of New Sidewalks and Shared Use Paths along State Highways[8]
		Access-Connectivity, Active Transportation[9]	# of Bicycle to School Days Programs
			# of Walk to School Days Programs
		Public Transportation, Active Transportation	% of Overall Youth Population that are Obese, Overweight[10]

[8] Multi-year evaluation to track progress towards performance targets
[9] Including present programs
[10] Ages 10-17

State	Source Document	Livability Goal	Performance Measure/Indicator
		Public Health	# of incidences related to diabetes, asthma per 100M people and physical activity levels
		Active Transportation	% increase in work commute by bicycle
			% Pedestrian Mode Shift
			% increase in annual transit ridership
Idaho	Statewide Bicycle/Pedestrian Study (2014)	Safety	# Pedestrian Collisions per 100M residents
			Annual Bicycle Crashes
		Access-Connectivity	% reduction in sidewalk gaps along State-owned roadways
			% of Sidewalks that are ADA (American Disability Act) compliant (along state-owned roadways)
		Access-Connectivity[11]	% of State roadways within 1 mile of Transit Stations with sidewalks
			% of State roadways within 3 miles of Transit stations with marked bicycle facilities
		Access-Connectivity, Active Transportation	# of MTA transit buses equipped with bicycle racks
	"2035 Moving Maryland Forward" (LRTP)	Safety	Annual # of Traffic Fatalities on all roads in Maryland
			Annual # of Serious Injuries on all roads in Maryland
		Active Transportation	Average Weekday Transit Ridership
Illinois	Statewide Bicycle Plan (2012)	See WalkBikeNC Plan	
Indiana	2013 Future Needs Report	Safety	# and % of Collisions on Public Roads
			# and % of Serious Injuries on Public Roads
		Access-Connectivity	Total Length of Sidewalks (% Change)
Iowa	Iowa in Motion - 2040 LRTP	Safety	% of Fatalities at Intersections (Includes measure for intersections where collision rates are higher than state averages)

[11] Once data tracking is established

State	Source Document	Livability Goal	Performance Measure/Indicator
			# of Serious Injuries at Intersections
		Safety (low volume roads <400 vpd)	# of Fatal Collisions on Local Roads
			# of Serious Injury Collisions on Local Roads
Kansas	Transportation Plans do not provide performance measures for livability		
Kentucky	Statewide LRTP	Safety	Vehicle-related Fatality Rate
			Vehicle-related Rate of Serious Injury
Louisiana	2015 Statewide Transportation Plan Update	Safety	# of collisions with pedestrians
			# of collisions with bicycles
			# of collisions with trucks
			Rate of collisions with trucks
			# of collisions with transit vehicles
			# of collisions at rail crossings
		Access-Connectivity, Active Transportation	# of parishes with general transit services
		Access-Connectivity, Equity, Active Transportation	# of parishes with elderly, handicapped transit services
	Bicycle & Pedestrian Plan (2009)	Safety	Rate of collisions with pedestrians
			Rate of collisions with bicycles
			# of severe injuries with pedestrians
			# of severe injuries with bicycles
Maine	LRTP	Safety	# (and severity) of vehicle collisions
	Maine Strategic Transit Plan 2025	Safety	# of Fatalities per 1M rides
		Active Transportation	Total Unlinked Passenger Trips/Total Service Area Population
Massachusetts	Performance Measures 2015	Active Transportation	Commute Times and Congestion
		Safety	Fatalities per 100M VMT
	2040 LRTP	Access-Connectivity	Hours of Delay (by Average Driver) per 1000 VMT
		Safety	# of Collisions at Intersections, Interchanges

State	Source Document	Livability Goal	Performance Measure/Indicator
	GreenDOT	Access-Connectivity, Equity	% of Residents w/ Access to Transit Services
			% of Residents w/ Access to Pedestrian Facilities
			% of Residents w/ Access to Bicycle Facilities
			% of Residents w/in 1/2 mile of Rapid Transit Stop
			% of Residents w/in 1/4 mile of Bus Route, more than 1/2 mile of Transit Stop
			% of Residents w/in 1/4 mile of Bicycle Infrastructure
			% of Residents w/in 1/4 mile of Pedestrian Infrastructure
		Active Transportation	Commuter Mode Split
			Person Miles Traveled (Bicycle)
			Person Miles Traveled (Pedestrian)
			Daily VMT (Automobiles)
			Length of Bicycle Facilities
			Length of Pedestrian Facilities
			Bicycle Parking Facilities at Transit Stations
		Safety	Fatalities by Mode Choice
			Serious Injuries by Mode Choice
Michigan	Driven to Excellence Report -2016	Active Transportation	% Change of Ridership on Local Bus Transit
Minnesota	Bicycle Plan	Safety	Bicycle-Vehicle Collisions per Year
			% Change Bicycle Ridership / Bicycle Collision Rate Change
		Active Transportation	% of Bicycle Commuters
			% of Regular Riders (at least 1x per Week)
			% of Ridership from Women
	Performance Measures Report	Safety	% of Traffic Fatalities
			% of Traffic Serious Injuries

State	Source Document	Livability Goal	Performance Measure/Indicator
		Active Transportation	Twin Cities Metro Area Transit Ridership (Urban Ridership)
			Greater Minnesota Transit Ridership (Suburban Ridership)
		Active Transportation, Access-Connectivity	Sidewalk Inventory
Mississippi	MULTIPLAN 2040 (Multi-Modal Transportation Plan)	Safety	Fatality Rate per 100M VMT
			Bicycle Crash Rate per Year (5 Year Periods)
			Pedestrian Crash Rate per Year (5 Year Periods)
		Active Transportation	Change in Urban Transit Ridership
			Change in Rural Transit Ridership
Missouri	Transportation Plans do not provide performance measures for livability. Livability performance measures provided by Regional MPOs (e.g. East-West Gateway Coordinating Council (St. Louis))		
Montana	Transportation plans currently do provide performance measures for livability. Long-Range Transportation Plan expected to be complete in 2017.		
Nebraska	2014 Annual Performance Report	Safety	Crash/Collision Rate
	Vision 2032 LRTP	Active Transportation	VMT Traveled by Vehicle
			% of Total Trips (Vehicle-Based)
North Carolina	2015 Annual Performance Report	Safety	Fatality Rate per 100M VMT
		Access-Connectivity	% change of Ports Authority Cargo Movement[12]
	WalkBikeNC Plan	Safety[13]	Pedestrian Collision & Fatality Rates
			Bicycle Collision & Fatality Rates
		Access-Connectivity	Bicycle, Pedestrian Access to Transit

[12] Freight specific

[13] Police-reported, Data collected per capita & in areas of low vehicle ownership, low household income

State	Source Document	Livability Goal	Performance Measure/Indicator
		Access-Connectivity, Active Transportation	# of Direct connections to Transit Services
		Public Health	Rate of Physical Activity
			Rates of Obesity & Diabetes
		Public Health, Active Transportation	# of Walking to Local School programs
			# of Bicycling to Local School programs
		Active Transportation	% of Trips by Bicycle
			% of Trips by Walking
			# of Buses, Trains with bicycle racks
			% of Buses, Trains with bicycle racks
			Pedestrian, Bicycle Commute Mode Share
North Dakota	Transportation Plans developed by the Regional MPOs and not the State		
Nevada	Bicycle Plan	Safety	# of Bicycle-related Fatalities
		Safety	# of Bicycle-related Serious Injuries
		Access-Connectivity	# of roadway (miles) for regional bicycle routes (designated and improved)
		Public Health, Active Transportation	# of bicycle-related events held (statewide)
		Active Transportation	% Commute Mode Share by Bicycle
New Hampshire	LRTP	Access-Connectivity	Quality of Multimodal Corridor Connectivity/Accessibility
		Active Transportation	Mode Share, Work Commute
		Public Health	# Days Meeting Air Quality Standards
			Transportation-Related Emissions (tons)
		Safety	Fatalities per 100M VMT
			Serious Collisions per 100M VMT
New Jersey	LRTP	Access-Connectivity, Equity	Changes in Employment w/in 1/4 mi of bus line or 1/2 mile of rail station
			Changes in Households w/in 1/4 mi of bus line or 1/2 mile of rail station

State	Source Document	Livability Goal	Performance Measure/Indicator
			Changes in Population w/in 1/4 mi of bus line or 1/2 mile of rail station
			Changes in Employment w/in 1/4 mi of bus line or 1/2 mile of rail station near designated Transit Villages
			Changes in Households w/in 1/4 mi of bus line or 1/2 mile of rail station near designated Transit Villages
			Changes in Population w/in 1/4 mi of bus line or 1/2 mile of rail station near designated Transit Villages
		Safety	Collision rate per 100M VMT
			Serious injuries rate per 100M VMT
			Fatalities per 100M VMT
			Injuries and Fatalities involving bicyclists
			Injuries and Fatalities involving pedestrians
			Injuries and Fatalities involving heavy trucks
			Injuries and Fatalities involving transit vehicles
		Active Transportation	VMT per Household
			% Increase in Transit Ridership
		Access-Connectivity	% Population within X minutes of employment (vehicles)
			% Population within X minutes of employment (transit)
			% Population able to walk to transit (w/in 1/4 mile)
			% Population able to bicycle to transit (w/in 1/2 mile)
			# of parking spaces available for access to transit
		Public Health	# of days that exceed air quality standards
		Active Transportation	% truck VMT under congested conditions
			% of truck VMT in off-peak periods
			Share of Rail Mode

State	Source Document	Livability Goal	Performance Measure/Indicator
New Mexico	New Mexico 2040 (LRTP)	Safety	# of Fatalities per 100M VMT (Statewide, Rural, Urban)
			# of Serious Injuries per 100M VMT (Statewide, Rural, Urban)
			# of Pedestrian Fatalities per 100k Population (Statewide, Rural, Urban)
			# of Pedestrian Serious Injuries per 100k Population (Statewide, Rural, Urban)
			# of Bicycle Fatalities per 100k Population (Statewide, Rural, Urban)
			# of Bicycle Serious Injuries per 100k Population (Statewide, Rural, Urban)
		Access-Connectivity, Equity	% of 60+ (reported) residents that have transportation options sufficient to maintain independent lifestyle
		Active Transportation	Rail Runner Annual Ridership
			Park-and-Ride Annual Ridership
	2040 Freight Plan	Safety	Average Annual Accident/Incident Rate (per 1k RR miles)
			Average Annual Fatality Rate (per 1k RR miles)
			Average Annual Injury Rate per 1k RR miles
			Total # of Fatalities (5-year total)
			Total # of Injuries (5-year total)
			Total # of Trespasser Fatalities (5-year Total)
New York	Transportation Plans developed by the Regional MPOs and not the State		
Ohio	Strategic Highway Safety Plan	Safety	# of Fatalities (% Changes)
			# of Serious Injuries (% Changes)
			Fatality Rate
			Serious Injury Rate
	Active Transportation Plan	Access-Connectivity	Population within Distance of Bicycle Facility
			Miles of Bicycle Lanes
		Active Transportation	Activity in Active Transportation Mode Choices

State	Source Document	Livability Goal	Performance Measure/Indicator
Oklahoma	2015-2040 LRTP	Safety	Annual Vehicle Fatality Rate
			Annual Vehicle Serious Injury Rate
		Active Transportation	Annual Passenger Rail Ridership
Oregon	Bicycle & Pedestrian Plan	Safety	# of Bicycle, Pedestrian Fatalities (5-year Average)
			# of Bicycle, Pedestrian Serious Injuries (5-year Average)
		Safety, Active Transportation	% of public that feels safe walking, bicycling in community
		Access-Connectivity	% of streets w/in 1/2 mile of transit stop w/ sidewalks
		Access-Connectivity, Active Transportation[14]	% of streets w/in 1 mi of transit stop w/ bicycle LTS 2 rating
		Access-Connectivity[15]	# of local jurisdictions w/ bicycle friendly community designation
			# of local jurisdictions w/ walk friendly community designation
Pennsylvania	Development of the Long-Range Transportation Plan (PA on Track: 2040 Plan) in Progress		
Rhode Island	LRTP	Active Transportation	Mode Share % (by Bicycle)
			Mode Share % (by Pedestrian)
			Mode Share % (by Transit)
			# of Transit passengers/hour of fixed route services
		Access-Connectivity	% towards progress of 200-mile completion of sidewalks
		Equity	% of FIP Participants residing w/in 1/4 mile of fixed transit route
		Safety	Fatality rate per 100M VMT
			Crash Rate per 100M VMT

[14] For future evaluation
[15] For future evaluation

State	Source Document	Livability Goal	Performance Measure/Indicator
			# Serious Pedestrian Injuries
			# of Serious Bicycle Injuries
South Carolina	2040 Multimodal Transportation Plan	Safety	Rate of Vehicle-related Fatalities
			Rate of Vehicle-related Serious Injuries
			Rate of Bicycle, Pedestrian Fatalities
			Rate of Bicycle, Pedestrian Serious Injuries
			# of crashes at intersections with fatalities
			# of crashes at intersections with serious injuries
			% of crossings with active safety warning devices installed
		Active Transportation	% of transit needs met
South Dakota	Transportation Plans developed by the Regional MPOs and not the State		
Tennessee	LRTP (System Performance)	Safety	Fatality Rate per 100M VMT
			Reduction in Fatality Rate per 100M VMT
		Access-Connectivity, Active Transportation	Miles of State Routes accommodating Bicycles
			Miles of State Routes accommodating Pedestrians
	LRTP (Mobility)	Equity, Active Transportation	Change in Zero Vehicle Households
		Active Transportation	Commuter Mode Split
			Change in Annual Transit Ridership
Texas	Texas Transportation Plan 2040 (LRTP)	Safety	Fatality Rate (5 year moving average)
			# of Fatalities (5 year moving average)
			Serious Injury Rate (5 year moving average)
			# of Serious Injuries (5 year moving average)
		Public Health[16]	Daily kgs of VOC Reduced by latest Annual Program of CMAQ projects in areas with

[16] No targets yet set

State	Source Document	Livability Goal	Performance Measure/Indicator
			populations of 1 million or greater (5 Year Average)
			Daily kgs of NOx Reduced by latest Annual Program of CMAQ projects in areas with populations of 1 million or greater (5 Year Average)
			Daily kgs of CO Reduced by latest Annual Program of CMAQ projects in areas with populations of 1 million or greater (5 Year Average)
Utah	LRTP	Safety	Annual Traffic-Related Fatalities (5+ Year)
	Strategic Direction	Safety	# of Fatalities by Mode Choice (5-Year)
Vermont	Bicycle and Pedestrian Plan (BPP)	Active Transportation	Commute Mode Share % (by Bicycle)
			Commute Mode Share % (by Pedestrian)
		Public Health[17]	# of minutes/day residents spend w/ bicycle activity
			# of minutes/day residents spend w/ pedestrian activity
		Public Health/Safety	Bicycling to/from schools for Safe Routes to Schools
			Walking to/from schools for Safe Routes to Schools
		Safety[18]	Pedestrian crashes/# of minutes walking (police-reported)
			Bicycle crashes/# of minutes bicycling (police-reported)
	Public Transit Plan	Active Transportation	Boardings Per Mile (per Service Category) (e.g. Urban, Rural, Small Town, etc.)
			% Increase in Transit Ridership
Virginia	"VTRANS 2035" - Multi-modal LRTP	Active Transportation	% change of roadway system with bicycle lanes
			% change of constructed bicycle trails
Washington DC	Transportation plans do not have performance measures that address livability		

[17] Data collected through public surveys

[18] These measures are desirable but no data is currently available

State	Source Document	Livability Goal	Performance Measure/Indicator
Washington	Bicycle & Pedestrian Plan[19]	Safety	# of annual bicycle-involved collisions (fatal, non-fatal)
			# of annual pedestrian-involved collisions (fatal, non-fatal)
			% of pedestrian, bicycle fatalities (per age group) (0-14, 71+)
		Access-Connectivity	% of population w/in 2 miles of goods, services
		Access-Connectivity, Active Transportation	Net total linear miles of designated bicycle facilities (e.g. bike lanes, shared use paths, etc.)
			Net total linear miles of sidewalks on state routes within cities
		Public Health	Bicycle VMT
			Pedestrian VMT
		Public Health, Active Transportation	% of students walking, bicycling to schools
		Active Transportation	% of trips, miles traveled by bicycle, walking
			% and trip types bicycling, walking
	Public Transportation Plan (2016) [20]	Access-Connectivity	Access to Human Services, Schools
		Access-Connectivity, Equity	# of Housing Units in proximity to Public Transportation
			Types of Housing Units in proximity to Public Transportation
			Access to Public Transportation (Race, Disability, Income)
		Access-Connectivity, Active Transportation	Access to Jobs through non-Single Occupancy Vehicle (SOV) transportation mode choices
		Equity	Ratio of Transportation Costs to Household Income
		Public Health	Amount of GHGs (tonnage) cause by Transportation

[19] 2 to 15-year implementation period for measures in the Bicycle & Pedestrian Plan

[20] Future measures to be developed

State	Source Document	Livability Goal	Performance Measure/Indicator
		Active Transportation	Rate of Single Occupancy Vehicles
			Annual Ridership of Washington State Ferries
			Annual Ridership of Amtrak train service
			Annual Transit Ridership
			Mode Split (by Communities)
	Statewide Transportation Plan (2035)	Safety	Traffic Fatality Rate per 100M VMT
			Traffic Serious Injury Rate per 100M VMT
West Virginia	Strategic Highway Safety Plan	Safety	Fatality Rate per 100M VMT
			Serious Injury Rate per 100M VMT
			Crash Rate per 100M VMT
	Multi-Modal Statewide Transportation Plan	Safety	Fatality Rate per 100M VMT
Wisconsin	2030 LRTP	Safety	Fatality Rate per 100M VMT
		Active Transportation	Work Commute Mode Choice %
			Change in VMT (Automobiles, Trucks)
	Other livability performance measures developed by the regional MPOs.		
Wyoming	Wyoming Connects LRTP	Safety	Fatality Rate per 100M VMT

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CFIRE

University of Wisconsin-Madison
Department of Civil and Environmental Engineering
2205 Engineering Hall
1415 Engineering Drive
Madison, WI 53706
Phone: 608-263-9490
Fax: 608-262-519
cfire.wistrans.org